DESIGN OF A SOCIOECONOMIC MONITORING AND EVALUATION SYSTEM TO MANAGE INTEGRATED CONSERVATION AND DEVELOPMENT PROJECTS IN MADAGASCAR

By

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To My Children.

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The issue examined is how to sustain socioeconomic development, while simultaneously conserving resources and the environment for human population livelihoods in general, in the short term, and across generations in Madagascar. The focus is on a grand system of relationships composed of resources, people, and institutions.

A socioeconomic monitoring and evaluation system (SEMES) provides a methodology for sustainability analysis of integrated conservation and development in Masoala, northeastern Madagascar. It considers the Integrated Conservation and Development Project (ICDP) manager's concern for maintaining resilience of the protected area along with the well-being of nearby farm households. The SEMES, a package of management tools, is composed of three systemic parts: 1) a linear

programming model (LPM); 2) an institutional cognitive pattern (ICP) evaluation model; and 3) statistical analysis (STAT). It is argued that changes, and/or constancies, of well-targeted indicators signal positive or negative effects on sustainability of integrated conservation and development, allowing for efficient management of development activities conducted in the ICDP system. Also, signals provide tools to decision-makers, especially the ICDP managers, for management and policy making purposes.

A human pressure (slash and burn or "tavy" in this case study) made in the protected area by a farm household is tied to a farm production subsystem, itself related to other subsystems in the farm household's livelihood system. The farm production subsystem is targeted for change. Results of LPM in the Masoala ICDP case study show that farm households rationally perform tavy culture because of their constrained possibilities. Prohibiting tavy decreases farm household welfare dramatically. A specific development activity, including its constraints and performance, introduced by the ICDP to respond to farm household needs and the pressure can be evaluated, monitored, and managed efficiently with the SEMES management tools.

The ICP evaluation model shows that if no intervention is made in the "traditional" setting of farm households, population growth and increasing food and non-food demands lead to the increase of secondary forests, and depletion of primary forests, natural resources, and biodiversity. However, the success of ICDP interventions with development activities might not be sustainable unless infrastructure and marketing systems are improved.

CHAPTER 1
INTRODUCTION

Problematique: The Malagasy Conservation and Development Paradigm

Socioeconomic activities in food and non-food production and consumption alter the environment, natural resources, and biodiversity in Madagascar. The desire of the human population in conducting the activities, of course, is to better its livelihood. A fundamental issue is how to lay a basis for sustainable development,[1] while simultaneously conserving resources and the environment for production, consumption, and human population livelihoods in general, in the short-term and across generations.

The problematic relationships in Madagascar's resource conservation and socioeconomic development paradigm are complex and urgent. As farm households' needs and production practices lead to disappearance of unique and endemic natural resources, biodiversity in protected areas is seriously threatened. Poverty, food security, and environmental degradation are legitimate concerns for policy and decision-makers,

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[1] "Today, there is still a real need to enable the operationalization of sustainability concepts. Farmers, researchers, and extension workers need a definition of sustainability that is scientific, open to hypothesis testing, and practicable. A general methodology for sustainability analysis does not exist at any level, though more progress has been made at some levels (e.g., the field level) than at others." (Kelly, 1995, p. 1-2)

"Sustainable development is itself something of a paradox. The phrase implies that something must change but that something must also remain constant. The paradox appears in a number of forms, and its resolution can provide the direction to seek for investments that could sustain development." (Holling in Gunderson et al., 1995, p. 25)

international donors, national and international planners and investors, and Malagasy producers and consumers.

This work designs a socioeconomic monitoring and evaluation system (SEMES) that has broad adaptability. It provides a methodology for sustainability analysis of the Masoala integrated conservation and development in northeastern Madagascar as an example of its use. This location provides empirical evidence for the design and methodology of the SEMES.

Through socioeconomic indicators at different levels in a "grand system of relationships," the evolution of the Masoala integrated conservation and development can be monitored and evaluated. The proposed methodology for ICDP management combines conventional (data analysis) and participatory (participating actors) monitoring and evaluation approaches, and considers the concern of the ICDP managers and decision-makers for sustainability and resilience of the protected area and farm household systems. The issues are addressed simultaneously, and studied in a grand system composed of resources, people and institutions.

The proposed socioeconomic indicators of sustainability focus on 1) the behavior of farm households in the peripheral zone of the Masoala protected area; 2) the institutional setting and environment of the integrated conservation and development; and 3) changes in the farm household, the protected area, and the institutional systems. It is argued that changes, and/or constancies, of the indicators signal positive or negative effects on sustainability of integrated conservation and development. Signals allow for rectification, improvement, modification and/or reorientation of activities conducted in

the ICDP system. Also, signals provide tools to decision-makers, especially the ICDP managers, for management and policy making purposes.

Overview of Problems and Causal Relationships

The Masoala ICDP (micro level) evolves in the socioeconomic situation of Madagascar (macro level). Witnessing "extreme human poverty" among the rural population during trips around ICDPs in the northern region of Madagascar, a USAID evaluation team (Barbour et al., 1992) suggests that unless the macroeconomic environment is improved, the ICDPs will always encounter hinderances in their conservation and development efforts. Recognizing this perspective, this work provides a descriptive macro background about Madagascar, but focuses on the analyses of the micro level situation as depicted in the case of Masoala.

According to World Bank (1995) figures, Madagascar is among the poorest and most environmentally at risk countries in the World (Chapter 2). Poverty and environmental degradation co-exist in the agriculture-based economy. About 75% of the Madagascar population is estimated to be farm households. Poverty prevails in both the urban and rural sectors.

Population growth and socioeconomic factors interrelate, and mutually reinforce environmental and biodiversity degradation. Increased demand for food and non-food items for a growing human population is not met by equal changes in the supply from agricultural production in Madagascar. As a corollary, low purchasing power for farm households, along with weak infrastructure and marketing systems, limits access to

available food and non-food items. As a result, resources from primary forests and biodiversity are exploited to compensate for the gap between demand and supply from production and/or purchase. Major concerns to the national and international communities are the competitive relationships between conservation of Madagascar's disappearing unique and endemic natural resources and biodiversity, and socioeconomic development of the human population.

As illustrated by the Masoala situation, but holding true around all protected areas in Madagascar, human pressure[2] on the environment constitutes one of the leading threats to conservation. Pressure is especially exerted by peripheral zone farm households in the protected area for purposes such as food production and consumption, income, and energy (Swanson, 1995, 1996; Barbour et al., 1992; Kremen et al., 1997; PCDI Masoala, 1996).

It is believed that the Malagasy farm household looks for the best alternatives, among those available to it, in production, income, expenditures, and consumption. That is, the household is socioeconomically and culturally rational. Farmers attempt to improve household welfare, given the resource constraints they face in production, in geophysical and socioeconomic environments, such as land availability and land characteristics, and in markets and institutional settings in which they must function. In order to achieve its objectives and goals subject to resource constraints in production, the farm household is assumed to maximize its annual cash balance available for

[2] The pressures are destructive actions exerted by the rural households in the protected areas, such as "Tavy" (slash and burn) culture, collecting and gathering natural resources (honey, wood and plants for different purposes, bamboo, crayfish, frog and other items), hunting (lemurs, wild pigs, and other animals) and forest pasturing of cattle.

discretionary spending. In such a framework, presented with resource constraints and a constrained overall environment, the farm household forms its behavior with the best available information it possesses; that is, farm household circumstances result from various possibilities and constraints. By understanding the limited production, income, and consumption possibilities available to farm households, it is possible to understand how poverty of the farm household is a result of resource constraints, and consequently, why and how the protected area is depleted.

One pressure, the "tavy" (slash and burn practice of rice culture), is chosen for specific consideration, and the cropping system of Masoala farm households is simulated with a linear programming model (Chapter 3).

To address the concerns of conservation and development simultaneously, the USAID funded Integrated Conservation and Development Projects (ICDP) were initiated in 1989 under the Sustainable Approaches to Viable Environmental Management (SAVEM) program (Swanson, 1995). Madagascar depends heavily on international aid and assistance for the conservation of its environment and its socioeconomic development. Concepts and causal relationships about conservation and development dealt with by the ICDP derive from different levels of influence, intervention, and perspectives, i.e. international, national, local, and individual. Such differing perspectives influence the ICDP activities. The Masoala ICDP is one of 37 protected areas designated as functioning or potential ICDPs in Madagascar (Figure 1.1).

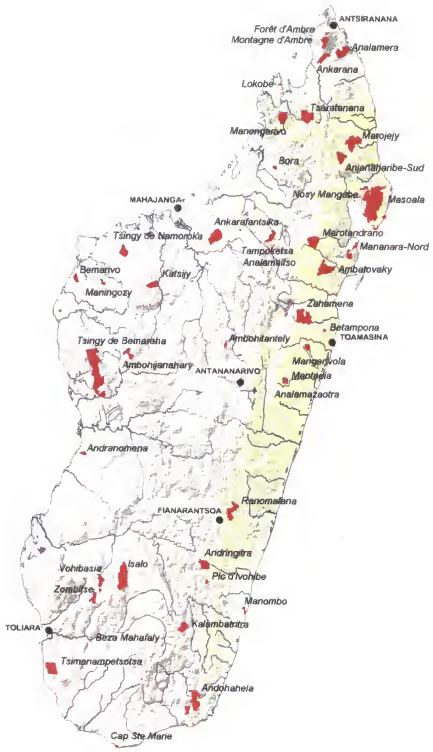

Figure 1.1. Map of protected areas in Madagascar.
Source: Tropical Research and Development, Inc., Gainesville, 1996.

The Integrated Conservation and Development Projects (ICDP)

Paradigm. The Malagasy conservation and development paradigm can be conceptualized as systems of resources and people (Chapter 4). The concept of integrated conservation and development emerged from the relationships between those systems. Farm households in the peripheral zone around a protected area exert destructive pressures on natural resources and biodiversity through their livelihood activities. These pressures are caused by constraints faced by the farm households to satisfy their basic needs, such as production, income, consumption, and energy. In other words, the problematic in this paradigm points to these relationships between the resource systems (protected area) and people (peripheral zone farm household).

Basic systems. The integrated conservation and development paradigm by itself is a grand system of relationships as sketched in Figure 1.2. Four sets, each of which is a system with subsystems, interrelate and interact in the grand system. They include 1) the institutional set--international and Malagasy institutional and organizational systems, and the ICDP system; 2) the protected area set--natural systems; 3) the farm household set--livelihood systems in the peripheral zone; and 4) the introduced development activities set--varied types of activity systems and subsystems. Institutions and development activities are introduced in the conservation and development paradigm, leading to the ICDP scheme.

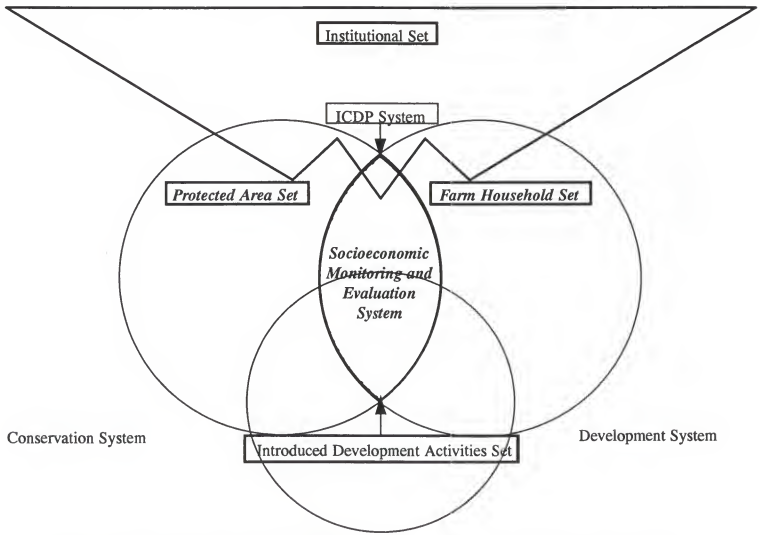

Figure 1.2. The grand system of relationships in conservation and development: The basic sets

The self-regulation of, and interrelations and interactions among, these sets and their subsystems determine their own and the overall system's structure, organization, internal and external linkages, resilience[3] and sustainability. They constitute the grand system within which the ICDP is expected to manage change.

In this framework, the grand system of relationships is said to be sustainable when the synergy among the sets and their subsystems maintains the viability, durability and operationality of the system in space (physical location) and time (from season and year to across generations). Some subsystems will work positively and others negatively toward sustainability. Boundaries being necessary for systemic approaches, it is evident that many other subsystems and factors are relegated as secondary. From an ICDP management and socioeconomic monitoring and evaluation point of view, the subsystems described are thought to contain the leading factors for integrated conservation and development sustainability.

Goals and expectations. Framers of the ICDP concept expected it to provide new Sustainable Approaches to a Viable Environmental Management (SAVEM) program, promoted and applied by USAID in Madagascar (Swanson, 1995, 1996; Barbour et al., 1992). The approaches stress the importance of the role and impact of peripheral zone farm households in the management of protected areas by involving them through introduced development activities. Introduced development activities are expected to meet the basic needs of these farm households. The ICDP expects farm households will

[3] Resilience is defined as the capacity and ability of the system in question to absorb exogenous and endogenous destabilizing factors, and/or to adjust for continuity in its survival pattern relative to those factors.

consequently decrease and/or cease the exploitation of natural resources and biodiversity in the protected area.

Thus, these approaches are designed and expected to reduce the conflict over sustainable use of natural resources by integrating the knowledge base and strategies for socioeconomic development with the conservation challenge. In other words, the ICDP applies the socioeconomic development knowledge base and strategies to approaches for identifying and achieving the complementary goals and objectives of conservation and development. As such, a simultaneous goal of the ICDP, besides conservation of the protected area, is to improve the standard of living[4] of the farm households in peripheral zones. The hope is that this improvement will decrease and/or cease the pressures exerted by farm households in protected area.

Actors in the institutional and farm household sets (Figure 1.2) do not have the same expectations, objectives and goals (Chapter 4, 5, 6). For example, conservation stands as a priority for donors, but relatively short-term food security concerns are at the core of the socioeconomic development issue for peripheral zone farm households. In between donors and farm households, actors see the problematic in the conservation and development paradigm from other perspectives, such as input and total factor productivity and sustainability. In other words, global goals and objectives of conservation and development might be shared, but specific objectives and strategies as priorities and concerns differ in the field. Adding a time dimension, where perspectives on specific

[4] The households' standard of living refers to the satisfaction of their socioeconomic and cultural needs, such as levels of production, revenue, consumption, schooling and health.

objectives and strategies change due to changes in institutional structures and actors, renders the problem more complex.

Development activities. The ICDPs introduce development activities to the farm households and communities in peripheral zones that exert destructive pressures in the protected area. These activities provide production, revenue, consumption, and/or socio-cultural infrastructure alternatives. Development strategies in the ICDPs often include many activities which target a combination of the components of the problematic relationships in the systems of resources and people (Swanson, 1995, 1996; Barbour et al., 1992).

However, it is possible that expectations and the ICDP goals may not be reached because of field implementation problems, resulting from uncertainty, vagueness and conflicts in the definitions of what is to be done and how (Swanson, 1995, 1996). Insuring the efficiency, viability, and sustainability of the new integrated conservation and development approach requires managerial provision for sustainable socioeconomic alternatives directly related to the pressures exerted by the farm households in the peripheral zones. Further, goal achievement means providing a suitable environment for socioeconomic activities, as well as involving farm people in the management practices of their own resources, as they become involved with the varied socioeconomic alternatives.

One aspect of the present research is to focus on a framework to evaluate and monitor the allocation and use of resources by peripheral zone farm households. It is assumed that other community development activities, such as health and education, are

conducted as a part of the ICDP efforts. This work will then look at individual and group-oriented development activities, focusing on farm household production, income and consumption. It also assembles a methodology which can be applied to development activities related to conservation of the environment under various circumstances in Madagascar.

As such, the socioeconomic monitoring and evaluation system (SEMES) to be proposed constitutes a fifth set (Figure 1.2), which would evaluate and monitor the effective linkages at the intersection of the existing four sets--institutions, peripheral zone farm household, protected area, and introduced development activities (Chapter 6). The goal is to ensure efficient and lasting management of sustainable environmental and socioeconomic systems, in the face of complex and unpredictable events.

The Masoala Peninsula ICDP. The Masoala peninsula was among the first priority sites in the Madagascar Environmental Action Plan in 1990. It is located between the Toamasina and Antsiranana provinces, in the "Fivondronana" (districts) of Maroantsetra and Antalaha. The size of the peninsula is 520,000 hectares with 11 watersheds. A population of about 45,000 inhabitants live in a peripheral zone to 110,000 hectares of primary forest. A national park composed of a terrestrial part of 210,000 hectares and a marine part of 6,000 hectares constitutes the main block to be protected by the ICDP (PCDI Masoala, 1996).

While the Masoala ICDP is now run by a consortium of international NGOs (CARE, Wildlife Conservation Society and the Peregrine Fund) under the guidance of DEF (governmental Direction of Waters and Forestry) and ANGAP (National

Association for the Management of Protected Areas), it began differently. The DEF started in 1989 as a USAID funded conservation and development project with national NGOs. Objectives were not met and the project was suspended in 1991. A transitory phase of conceptualization and reorientation was conducted by CARE International in 1992, leading to the USAID SAVEM funded Masoala ICDP in 1993 (Kremen et al., 1997).

The goal of the Masoala project is to ensure "the long-term health of the biological and human spheres." Three mid- and long-term objectives are as follows: 1) the conservation of Masoala biodiversity by the year 2000; 2) adoption by 50% of pilot zones' population of one or several practices for sustainable management of resources in 1996; and 3) a supportive local, regional, national and international institutional environment to ensure the continuity and continuance of integrated conservation and development activities in the Masoala region by the year 2000.

To attain the goal and objectives, four strategies are followed: 1) management of the protected area (delimitation and park management); 2) sustainable exploitation and use of natural resources; 3) organization of rural communities; and 4) institutional development at different levels.

The lessons learned from 1995 point to the desire of the Masoala ICDP to harmonize the goal and objectives of the project with the interests of the local population. A felt need to reinforce the internal (within project) and external (local, regional, national, international) communication emerged and called for an effective and supportive

institutional environment. In response, the Information-Education-Communication (IEC) unit was created.

Research Problem

Insuring the management and operationality of the linkages between development activities and conservation is a requisite for the efficiency, viability, and sustainability of the integrated conservation and development approach. This can be monitored and evaluated through the socioeconomic effects of introduced development activities on the farm household standard of living and the impacts of these activities on its use of natural resources in the protected area. These programs must consider the needs and aspirations of people. However, lack of sound information on target groups and target areas presently hinders the design, consistency, focus, implementation, and management of conservation and development programs.

Understanding production, income generation, food consumption and food security issues at the farm household level in the peripheral zone, and cognizance of the institutional setting of the ICDP are therefore needed. The desired knowledge should give insight into various policy questions and general beliefs which remain crucial in identifying, defining and evaluating socioeconomic development and conservation strategies and consequences. Such information helps strategists and decision-makers anticipate and understand changes, derived pressures and stresses brought on by introduced development activities. The need for information arises at all levels, from the senior decision-makers at the national coordination and international donor levels to the

grass-roots and individual levels. In our case, this translates from ANGAP, DEF and USAID to the ICDPs[5] and to the farm household members.

Well-defined and appropriate indicators and methods for assessing interactions among protected area, peripheral zone farm household, and ICDP institutional environment are needed. Lack or insufficiency of such indicators and methods precludes solid bases for decision-making at all levels. This deficiency detracts from a self-regulating sustainability of integrated conservation and development systems. Further, the scarcity of scientific research findings in socioeconomic monitoring and evaluation of the development process jeopardizes the chance that resource utilization will improve farm household welfare and reduce negative impacts on protected areas, natural resources and biodiversity. Finally, rarity of reliable farm level information prevents the formulation and selection of sound conservation and development policies in the decision-making process.

Hypotheses

Best and sufficient information, from a socioeconomic theory perspective, is one prerequisite for optimum decision-making at the farm, ICDP, and national management levels. The following hypotheses are designed to express the broad need for knowledge

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[5] ICDPs are defined as the organizational entities which manage the projects at the field level, such as CARE International, World Wildlife Fund, and so on.

The National Association for the Management of Protected Areas (ANGAP) is a Malagasy institutional organization coordinating the management of all protected areas, and so all ICDPs in Madagascar. DEF is the Malagasy government Direction of Waters and Forestry.

USAID is the main donor of the ICDPs considered in this study.

of linkages from farm households to the national and international levels. For purposes of illustration, specific observations concerning the hypotheses apply to the Masoala case.

1. It is expected that the identification, evaluation, and monitoring of development activities, which are technically, environmentally, socioeconomically, and institutionally feasible, by well informed managers will improve the well-being of peripheral zone farm households and decrease and/or cease the pressures exerted by them in the protected areas. That is, a socioeconomic monitoring and evaluation system (SEMES) will have a positive impact on farm household welfare and reduce human pressures in the protected areas.

2. Building from the farm household level:

    a. If the production activities thought to deplete the protected area are restricted, then the welfare of farm households in the peripheral zone will decrease, ceteris paribus.

    b. Households that diversify their agricultural activities and buy rice are at least as well off as households that produce enough rice to meet their subsistence needs.

3. The understanding, description, and analyses of concepts and their relationships (including linkages at various levels) about conservation and development will converge and focus the values, beliefs, and incentives of the institutional organizations and actors involved in the ICDP interventions.

Objectives

The goal of this research is to contribute to the success, efficiency and sustainability of new approaches to viable environmental management. This will be achieved by providing perennial management tools through a socioeconomic monitoring and evaluation system (SEMES) that can detect success or failure, efficiency and sustainability of development activities in reducing human pressures in Madagascar's protected areas. Situation analysis, mission, strategies, planning, and project/activity design are considered. Evaluation and monitoring provide feedback to the real world situation when observing the products and impacts of project activities.

The research methods include: 1) a linear programming model (LPM) that describes and analyses the peripheral zone farm household cropping systems, examining especially production, income, and consumption, and 2) an institutional cognitive pattern (ICP)[6] evaluation model that describes and analyzes the institutional setting of the ICDP. A tool not used in this research but necessary for a long-run management approach is 3) a statistical (STAT) analysis using data as indicators to monitor for sustainability in an

[6] "The nature of people's aspirations, needs, values, beliefs and preferences and their representation is a debatable, but unavoidable, issue due to its implications for research.... Thus, a premise is established that representations of aspirations, needs and knowledge are selectively chosen and formulated as causal concepts in the process of specifying a problem and opportunity domain for action in the solution of an identified social problem.... As a decision-making framework such a [institutional cognitive] pattern can bring values, beliefs, knowledge, processes, policies and objectives into a causal representation; all of these representations or concepts are selected and formulated by the decision makers with a shared sense of commitment and, also, as determinants of their behavior." (Fajardo, 1995, pp. 35, 36, 41)

ICDP. Some of these indicators are presented in a summary statement for the overall framework (Chapter 6).

This research proposes a SEMES which looks at the links among the ICDP development activities, the well-being of peripheral farm households and their exploitation of protected areas. The concepts and methodologies developed are designed to be useful to the ICDP managers and decision-makers, ANGAP, DEF, and the donors (USAID) for optimum decision-making in conservation and development management. As a further extension, the outcomes are also expected to be applied to and improve how the peripheral farm households manage their production systems.

The Masoala location is selected because it contains the largest block of near intact primary forest with numerous biological treasures on the east coast of Madagascar. Further, it is among, if not the first ICDP where at least limited socioeconomic data for monitoring and evaluation purposes are available.

Procedures

Because concern is primarily for analysis of the relationships among the peripheral zone farm households, the pressures in the protected area, and the institutional setting surrounding the Masoala ICDP, systems procedures and adaptive management concepts are used.[7] The systems management approach allows identification and delimitation of

[7] "While systems can be conceptualized at any of many scale levels, a systems approach defines a specific scale of interest and an appropriate boundary of analysis. The systems approach to analysis is marked by recognition of the whole system and the interactions within that system rather than looking only at a system part.... Systems may be grouped together to form a larger system, and each system is itself made up of component subsystems. This structure is referred to as the systems hierarchy." (Kelly, 1995, p. 9)

the domains and relationships of analysis. An adaptive management approach provides the necessary flexibility in time and space to consider "uncertain" interactions among resources, people and institutions. The aim is to propose a SEMES that evaluates and monitors development activities at the peripheral zone farm household level. Such a SEMES is expected to help manage 1) the effects of development activities on farm household production systems and standard of living and 2) the impacts of these activities on household behavior towards the protected areas. For the sake of understanding, presentation, and operationality of a very complex task given to the ICDP field managers, the LPM and ICP evaluation, and long-term STAT indicators proposed in this work are maintained as simplified as possible. Also, such simplicity is dictated by the amount and nature of data available. Elements in each analytical subsystem can be increased and made more complex as needed for broader analyses, and as more data become available.

Successful management of ICDPs calls for an underlying assumption for the framework adopted. That is, the SEMES established will remain in place on a long-term basis. Thus, the SEMES can provide a permanent link among sets within the grand system of relationships (Figure 1.2). Evaluation and monitoring focus on these

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[7] (continued). "The basic tenets of adaptive management all deal with the unpredictable interactions between people and ecosystems as they evolve together.... The primary expectation of adaptive management is the unexpected. That is, systems are unpredictable.... Surprises are inevitable; hence policies must always be adaptive.... Recognition of processes at the appropriate space and time scales is reported by all the case studies as a clear bridge to improved management.... One of the challenges is to develop understanding and methodology that spans across space and time scales." (Gunderson, Holling, and Light, 1995, pp. 491, 528)

relationships by design. Management elements of the SEMES are expressed as interrelated tools or closely related subsystems (Figure 1.3).

The "real world" is conceptualized through the grand system of relationships. This complex "real world" is depicted as an ICP evaluation model and a set of STAT indicators. A linear programming model (LPM) identifies and evaluates relevant indicators to analyze the behavior and constraints of peripheral zone farm households. The LPM can be viewed, for analytical purposes, as receiving signals from, as well as sending signals to the ICP and STAT.

The ICP (ex-ante) evaluation model is a matrical iteration process based on concepts and relationships of institutional actors.[8] The "ICP evaluation model" is defined as the causal interrelations (patterns) among selectively chosen concepts shared by the institutional set (Figure 1.2) and the knowledge of linkages/relationships among those concepts (cognitive). It provides direction and initial, mid- and long-term periodic evaluation to the integrated conservation and development process. The concepts and relationships in the model are based on the literature and the experience of the researcher, concerning the issues that are evolving within the conservation and development paradigm in Madagascar and elsewhere. An analytical framework of an ICP evaluation model leads to the definition of the indicators to be evaluated and monitored, and to the specification of the monitoring model.

[8] It is a term given to a representation of a structural core made up of causal concepts and broad relationships that influence collective human behavior (Fajardo, 1993). It finds its source in Kosko's (1986, 1988) Fuzzy Cognitive Maps (FCM) theory.

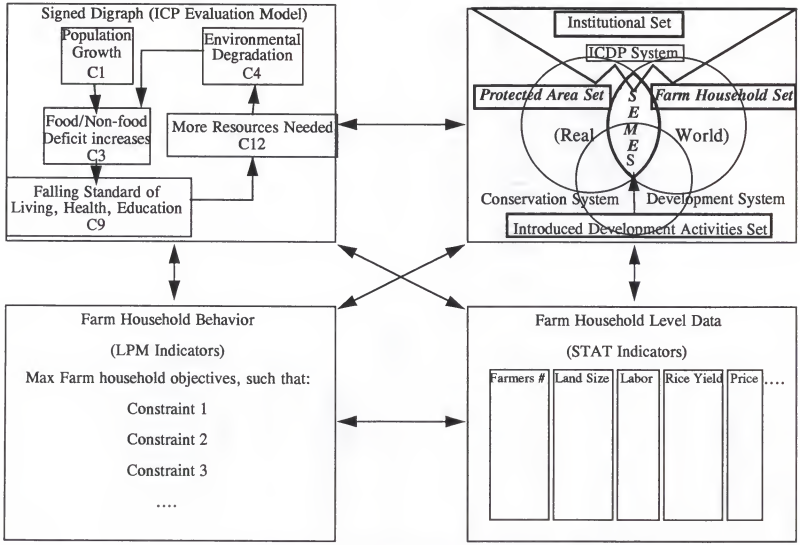

Figure 1.3. The socioeconomic evaluation and monitoring system (SEMES)

Statistical (STAT) indicators can contribute to both the ICP evaluation model and the LPM, and results of each can be statistically tested and monitored over time to observe how expectations and reality change. This requires of course time-series indicators which are not presently available.

This research is divided into 7 chapters. The present chapter introduced the study of a case to validate tools and a conceptual framework (SEMES) to be used by ICDP managers. A descriptive background of conservation and development in Madagascar and the Masoala peninsula as a basis for the remaining chapters is introduced in Chapter 2. Socioeconomic indicators to help in understanding household behavior are identified in Chapter 3 using a linear programming model (LPM). The LPM provides a basis for 1) a conceptual framework of the "real world" in Chapter 4, and 2) an analytical framework of the ICP evaluation model for understanding institutional relationships as an ex-ante approach to evaluation (Chapter 5).

Criteria to be monitored and evaluated are defined, and the foundations for a successful SEMES for the Masoala and Malagasy ICDPs follow in Chapter 6, putting together the linkages among the systems within the overall framework of the SEMES, including the LPM and ICP models, and STAT indicators.

Conclusions and recommendations based on the research and analyses of data from the Masoala ICDP are given in Chapter 7. Thus, issues in the conservation and development paradigm are investigated and insights on policies for regulating and affecting ICDPs are provided.

CHAPTER 2
MADAGASCAR UNDER STRESS

This chapter provides a general background on Madagascar, followed by a description of the Masoala peninsula ICDP domain. The macroeconomic indicators described, drawn mainly from World Bank (1995), give a rough idea of the country's socioeconomic stress. Madagascar is now one of the poorest countries in the world. Related to this, it has also become one of the most environmentally at risk countries in the 1990s. Some measures have been taken to protect the environment and to promote population welfare. Although part of one of the well endowed regions in terms of resources, the Masoala peninsula follows the general trends of the country's indicators.

Because of its "extreme poverty," Madagascar depends heavily on international aid and assistance for the conservation of its environment and its socioeconomic development. The World Bank (1995) estimates that the country's total external debt grew from US$ 1,223 million in 1980 to US$ 4,594 million in 1993 (US$ converted at official exchange rate).

Socioeconomic Situation

Access to Food

Madagascar is classified by the World Bank (1995) as a low-income, severely indebted, exporter of non-fuel primary products, with a declining GNP per capita. In 1993, GNP per capita stood at US$ 220. At the same time, total population was estimated at 14 million, of which about 74% are rural people. Total population is projected at 17 and 34 million in 2000 and 2025, respectively. Performance indicators for the economy during the periods of 1970-80 and 1980-93, relative to the average annual growth rate of population, suggest reasons for concern.

Food security can be defined as permanent access by all people to sufficient food for their well-being (World Bank, 1986). It follows that Madagascar has been experiencing food insecurity. This food insecurity is partly caused by insufficient production as related to the population growth. Indeed, if the Malagasy population growth rate is 3.3%, then food production should increase at the same rate, at least, for Madagascar to meet food security requirements without dependence on aid, world markets, and external debt.

In production, fertilizer consumption has regressed from 2,900 grams per hectare of arable land in 1979/80 to 2,500 grams in 1992/93, while land in production has increased. Food production per capita during the period 1980-93 indicates a negative average annual growth rate (-1.5%). These figures suggest that growth of factor

productivity in agriculture is stagnant and/or low. The insufficiency in production is also shown by cereal imports which amounted to 110,000 tons in 1980 and 111,000 tons in 1993. Further, food aid in cereals increased from 14,000 tons in 1979/80 to 58,000 tons in 1992/93.

Besides insufficient production, a second factor which restrains access to food in Madagascar is the population's low purchasing power. GNP per capita declined annually by 2.6% in the 13 years from 1980 to 1993. The level of GNP per capita at US$ 220 in 1993, considered low by World Bank standards, when combined with inflationary prices, exacerbates family purchasing power.

The average annual rate of inflation was 9.9% during 1970-80 and increased to 16.1% in the 1980-93 period. While the consumer price index rose from 30.46 in 1980 to 211.47 in 1993, the agricultural domestic price index increased from 29.59 in 1980 to 203.47 in 1993. The overall (GDP) price index was 29.50 in 1980 and 220.07 in 1993 (1987 = 100). The annual average conversion factor, Malagasy francs (FMG) per US$, "feeding" the inflationary situation, increased from 211.279 in 1980 to 1922.85 in 1993, and stabilized around 4,000 after 1994 when "liberalization" of the economy was in effect with structural adjustment programs. It reached FMG 5,000 per US$ in 1997. Difficulties prevail for efforts to counter inflation in the unstructured economic setting.

As might be expected, terms of trade (export prices f.o.b over import prices c.i.f) also deteriorated by declining from 121.4 in 1980 to 68.2 in 1993. The share of primary commodities in exports in 1970 was 84%, and it declined to 73% in 1993. The value of exports (f.o.b), from US$ 203 million in 1973, increased with a high of US$ 402 million

in 1980, before declining to US$ 267 million in 1992. Finally, the share of food in the value of merchandise imports was 12% in 1970 and 11% in 1993.

As a third factor repressing access to food, it is suspected that unequal wealth distribution as well as resource endowments, common among the rural population, limit food production and purchase (Mercado, 1989; Zeller, 1993; Abel-Ratovo et al., 1988, 1996). Thus, the majority of the population is expected to live in poverty.

In short, the macro data suggest insufficient agricultural production and the inability of people who must purchase food to acquire enough of it. Deteriorating production processes and output volume, unequal wealth distribution, low income, stagnating food imports, and increasing food aid suggest the majority of the Malagasy population cannot access enough food.

Alarming rates of deficiencies in some essential micronutrients in different regions of Madagascar have been reported by the National Program of Food and Nutrition Monitoring (PNSAN) of the Malagasy Ministry of Scientific Research (1993).

Food Insecurity and the Economy

The gap between the growth rates of population and production is aggravated by the characteristics of Malagasy agriculture and a weak infrastructure favoring exploitive marketing channels and practices at the farm level. Such weaknesses lead to low prices for producers and high prices for consumers, deteriorating terms of trade at the farm level, declining farm income and suspected increasing inequality in wealth distribution (Barbour et al., 1992; Abel-Ratovo et al., 1996). Weak industrial sector and service

sector growth place further pressure on agricultural areas. These combined factors contribute to the extreme poverty of Madagascar, affecting food security.

Poverty impacts directly on the allocation and use of resources in agriculture, and on the use of natural resources in protected areas.

Seasonal Rice Production and Food Insecurity

A fourth cause of food insecurity in Madagascar is the temporary decline in seasonal access to enough food. Insufficient production and the population's low purchasing power interact with the effects of both "hungry" and "normal" seasons in a given year at the farm household level.

The "hungry" season occurs during a part of the rainy season and a part of the dry season, at the pre-harvest period of irrigated rice. The shortage of rice, the staple food, during that period raises its price, making rice consumption inaccessible to much of the consuming population. At the farm household level, those people who are expected to be in difficulty experience a combination of the following circumstances: no or insufficient production, no or insufficient storage, and sold output at low prices for cash needs in the previous "normal" season. During the hungry season, the World Bank (Kahn, 1990) and the International Food Policy Research Institute (Zeller, 1993) suggest that over 40% of Malagasy rural households they surveyed consume less than 80 percent of the recommended 2,100 daily calories per capita as defined by the Food and Agricultural Organization (FAO) for a healthy and active life. In other words, food

insecurity is transitory[1] in Madagascar. Furthermore, it appears in its worst form (World Bank, 1986); that is, it produces famine in Madagascar as evidenced by facts in recent years in different regions.

The World Bank and IFPRI studies suggest also that food insecurity occurs during the "normal" season, which takes place during the post-harvest period of irrigated rice. During this period of the year, a little over 30% of the rural households surveyed consume less than 80% of the daily recommended 2,100 calories per capita (World Bank, 1990; Zeller, 1993). An anthropometric measurement of preschoolers aged six months to six years followed the same patterns as calorie consumption in terms of malnutrition during both seasons (Zeller, 1993). These findings indicate that food insecurity is also chronic[2] in Madagascar.

Food insecurity in Madagascar is probably based on rice which is the primary and staple food in the country. It has been estimated that Malagasy people consume about 172 kilograms of rice per capita per year (Mercado, 1989). Sixty percent of the caloric intake of rural households is derived from rice alone, although large variations prevail by region (rice-based producers or not), season (hungry, normal and intermediate seasons within year), and level of wealth (Zeller, 1993).

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[1] The World Bank (1986) suggests transitory food insecurity as being a temporary decline in a household's access to enough food.

[2] The World Bank (1986) suggests chronic food insecurity as being a permanently inadequate diet due to the inability to acquire food.

Rice as a Commercial Crop

Besides its importance as a staple food, rice is also one of the most important crops in terms of production volume and as a commercial crop. Most farm households are semi-commercialized; that is, they produce part for subsistence, and part for sale. From a net exporter of rice in the 1960s, Madagascar has become increasingly a net importer. This shift from exporter status is thought to be due to the rapidly growing population and to stagnant paddy yields (Mercado, 1989).

Mercado (1989) studied the constraints on rice production in a rice-based farming system in the northwest region of Madagascar and concluded that the farmers behave rationally as profit-maximizers after their food consumption needs are satisfied. This region is rice self-sufficient and exports rice to other (domestic) regions. However, she estimated that a yield per hectare increase of at least 40% was necessary for existing "improved technologies" to be adopted by farmers. Under prevailing prices, their adoption was not profitable.

How these changes in technology would influence broad conservation concerns, resource allocation and use beyond yield per hectare, and broader socioeconomic concerns has not been investigated.

Conservation

Madagascar has become one of the most environmentally at risk countries by the 1990s. People exploit natural resources and biodiversity in protected areas for reasons such as production, income, food, and energy needs. Consequently, the environment is

deteriorating. Among the most important types of pressures identified in protected areas are the following broad categories: production by "tavy" (slash and burn), grazing, tree cutting, collecting flora, hunting fauna, and mining (PCDI Masoala, 1996; Swanson, 1995; Kremen et al., 1997). Often, one farm household engages in one or a combination of these practices.

Production by "tavy" is a widespread slash and burn practice. Farmers clear and burn parts of forests. Among others, there are two main reasons for this practice: socio-culture and land constraints. It has been a Malagasy tradition in many regions to grow rice and other crops using the "tavy" techniques. Ashes from the burnt plants are considered as easy-to-get and no cost fertilizers. Also, the slash and burn practice facilitates land clearing, preparation, and maintenance for crop growing. Similarly, farmers practice "tavy" to extend their farm size. This second reason is true mainly for people around protected areas where indeed land constraints prevail. A review of the data on Masoala farm households suggests both irrigated rice and "tavy" areas exploited are positively related to farm size.

Another important pressure in protected areas is related to livestock raising. To feed the animals, farmers either burn land for pasture or send their animals into protected areas. The "tavy" and livestock raising practices result in soil impoverishment, forest clearing, and progressive destruction of protected areas.

Tree cutting, the next broad type of pressure in protected areas, provides for farmers' income and personal needs. Business in tree cutting consists of selling precious and/or non-precious woods, or charcoal. Tree cutting is also practiced to satisfy personal

needs, such as for home construction and for energy. As a result of tree cutting, trees and flora experience continuous depletion which, of course, impacts also on the habitats of fauna.

The next broad type of pressure in protected areas is the collection of flora. Certain plants are gathered for medical and food purposes. In particular, select wild racines and tubers, such as "ovy ala" or forest potato, are greatly appreciated during the "hungry" season. In addition, select flora can be used for commercial ends. In short, flora collection contributes to the on-going demolition of natural resources and biodiversity in protected areas.

Another important type of pressure in protected areas is destruction of fauna and biodiversity through hunting practices. Because of their inability to access food, farmers hunt forest animals, including endangered ones, for consumption and sale. For example, lemurs, birds and bats are slaughtered for their meat or sold as live animals. Snakes, chameleons and other endangered species are either sold or killed for income purposes. As a result, the fauna in protected areas is disappearing. Hunting practices also place pressure on biodiversity as areas where hunting takes place are often cleared. By the same token, spreading of pollen through birds and bats may decrease.

Mining in some parts of Madagascar has an impact on the environment, in particular on natural resources and biodiversity. These impacts are many fold. Among them are pollution and destruction of the immediate environment about the mining sites, which often are proximate to and/or inside protected areas. In addition, mining industry workers often exert destructive pressures similar to those of farmers to complement their

livelihood. Beyond these destructive practices, socio-political forces provide incentives to mining exploitation in view of expectations for "national socioeconomic benefits." Thus, national and international demand for mining products, flora as well as dead and/or alive fauna exacerbate the exploitation of natural resources and biodiversity.

These destructive actions result in deforestation and continuous extinction of fauna and flora. On an area of 587,000 km^2 for the whole country, the remaining total forest area changed from 171,000 km^2 in 1980 to 158,000 km^2 in 1990, with an annual deforestation rate of 0.8% of total forest area (World Bank, 1995). Thus, damaging "artificial" shocks to the "equilibrium" of the ecosystem are on-going.

It follows that these many pressures heavily affect the resilience and sustainability of ecosystems in Madagascar. Further, the regeneration of primary forests in Madagascar is very slow (Barbour et al., 1992), making the recovery of lost natural heritage unlikely. The overall bleak situation in the relationship between human development and conservation of Madagascar's environmental biodiversity has made of this country one of the most environmentally at risk in the world. Nash (1994) illustrates this situation:

> The magnitude of the problem is daunting, for virtually everything Madagascar's 12 million people do in their daily struggle against hunger can harm the island's delicate ecosystems.... Unfortunately, there is not much time left. Madagascar has one of the highest birthrates in the world, and its population is expected to double over the next three decades, putting excruciating pressure on the shrinking supply of arable land. So many of the slopes have been denuded of trees that by 2015, scientists predict, half of what remains will be lost,... and soon, some of the world's most magical forests and magnificent animals seem destined to disappear forever.

Actions are underway to protect the environment, preserve natural resources and biodiversity, and promote socioeconomic development simultaneously.

Conservation And Development Measures

Measures Taken

The challenges to conservation and development are thought to have existed in Madagascar for a long time. Hence, the resources, production and people paradigm is a universal and all-time situation. Population growth, increasing socioeconomic needs and relations, poverty, rate of deforestation, soil impoverishment and erosion, and international awareness make them more acute nowadays in Madagascar.

Preservation, by strict policing and isolation of protected areas, has been conducted with mixed results in Madagascar. Barbour et al. (1992) report successes and failures of this policy on the conservation side. Failures of most integrated rural development strategies and continued environmental degradation have also been reported, and put a question mark on the efficiency and efficacy of such policies alone.

To address the concerns of conservation and development simultaneously, the Integrated Conservation and Development Projects (ICDP) system was put in place in 1989 (Swanson, 1995). The physical domains of the ICDPs are delimited protected areas, surrounded by peripheral zones where farm households are located. There were 37 nationally protected areas in 1993 on 11,200 km^2, which represent 1.9% of the area of the country (World Bank, 1995).

Existing protected areas are classified as national parks, integrated natural reserves and special reserves (Figure 1.1). The Andranomena special reserve (6,420 hectares) was the first one created in 1955. Most of the protected areas were created

around the end of the 1950s, late 1960s and late 1980s. Their sizes vary from 600 hectares (Beza Mahafaly special reserve created in 1986) to 300,000 hectares (Masoala national park created in the late 1980s, classified in 1997), with a mean of 40,886 hectares. Ten protected areas are under the ICDP program. The size of peripheral (buffer) zones, and the population of surrounding local communities vary depending on the regions. The delimitations are still under discussion (Swanson. 1995, 1996). Geophysical situations, mixed with socio-cultural, legal and political issues, render these delimitations problematic.

Each ICDP is run by a consortium of international NGOs (WCS, Peregrine Fund, CARE in Masoala) led by one principal operator (CARE in Masoala). These NGOs operate under the guidance of Madagascar's ANGAP (National Association for the Management of Protected Areas) and government DEF (Direction of Waters and Forests).

Implementation and Design of ICDP Activities

The activities of ICDPs can be summarized into three broad categories:

1. Conservation, including such activities as the establishment of national parks, and the development and implementation of parks management;

2. Development, including the introduction of community, group and individual development activities to improve the socioeconomic welfare of farm households in the peripheral zones; and

3. Research studies that support the conservation and development units.

ICDPs and/or rural communities conceive and generate development activities. Actions are initiated by the ICDPs under two forms:

1. "Integration" ("portes d'entrées") activities are designed to consolidate the presence of the projects into the local communities through, for example, socio-cultural infrastructure, information--education--communication on conservation and development matters and issues; and

2. Individual or group activities generate alternatives for production, revenue and/or consumption, such as tourism-related activities, agroforestry, and an Intensive Rice Culture System ("SRI"). These activities are directly linked to possibly reducing the production, revenue and/or consumption problems that cause pressure in the protected areas by farm households.

Lessons Learned

It is agreed that enforcing a preservationist model alone is not desirable. The livelihood of people surrounding protected areas needs to be taken into account in the conservation and development paradigm (Swanson, 1995, 1996; Barbour et al., 1992; Kremen et al., 1997). It is assumed that the conservation motive must be integrated with the socioeconomic conditions. Among the activities called for by the ICDPs are monitoring and evaluation of the ICDP itself, conservation and development. Organization charts of all ICDPs, and ANGAP, show these management divisions.

Actors in the ICDPs agree on goals but differ in crucial design and implementation of actions to be undertaken. Failures in measures and actions may result

from a lack of shared beliefs, values and incentives. Consequently, ICDP measures may fail to reach overall goals because of a lack of sound and agreed upon socioeconomic criteria for monitoring and evaluation strategies. Good monitoring and evaluation in conservation cannot succeed by ignoring socioeconomic concerns.

Consequently, ICDP actions will fail in the long run if socioeconomic aspects related to environmental protection are overlooked. Thus, there is a need for a sound strategy in socioeconomic monitoring and evaluation. The purpose of this research is to suggest this strategy, and identify and clarify the linkages in the grand system of relationships in the conservation and development paradigm.

The Masoala Peninsula ICDP[3]

During the phase of reorientation of the conservation and development project in the Masoala area in 1993, different pressures and their reasons, intensity and distribution in the protected area were identified by the project team (ICDP Masoala, 1996; Swanson, 1995). In 1994, the project team determined and ranked, in terms of severity, the following human extraction pressures 1) "tavy" culture (slash and burn farming); 2) illicit forest exploitation (logging); 3) cash crops in the protected area (coffee, cloves, vanilla); 4) removing wood for construction; 5) removing secondary forest products (plants, eels, shrimp, crabs); 6) fishing; 7) hunting (lemurs, crocodiles, birds); 8) pasturing of cattle within the protected area; and 9) prospecting for minerals.

[3] This section draws heavily on Kremen et al. (1997), ICDP Masoala (1996) and Swanson (1995, 1996). Priorization and ranking of pressures and their causes are different in ICDP Masoala (1996) and Swanson (1995). We show the ICDP Masoala version.

The prioritized principal causes of these pressures are 1) satisfaction of food needs; 2) traditional land tenure system; 3) demographic pressure; 4) lack of, or insufficient, community structures; 5) lack of technical information; 6) custom and tradition of slash and burn agriculture; 7) lack of protected area surveillance and patrol system; and 8) financial needs.

The development activities of the Masoala ICDP are mainly under the department of Rural Animation and Development, but exist also in other departments such as the unit Information-Education-Communication (IEC). The strategies and activities of this department are reported in Table 2.1 (PCDI Masoala, 1996). It would appear that assumptions and expectations about the development activities are debatable when employed for design and implementation.

Table 2.1. Development activities strategies and activities of the ICDP Masoala (compiled from ICDP Masoala, 1996).

Strategies	Activities	Assumptions and expectations of project team
1. Community participation/ Organization of rural community.	i. Operationalize community action plans: constitute community groups, identify and conceptualize development activities, train members, provide inputs, follow-up and support household enterprises. ii. Support farmers' organizations, input channels, marketing, training and support.	i. Ensure local participation and sustainability of development activities, and reinforce the structure of local community. ii. Improve the control and management of the economic environment, and the structuration/organization of producers (collaboration with LOVA program and ODR Antsirabe).
2. Sustainable management of marine resources.	i. Establish permanent reserves. ii. Establish a sanctuary for marine mammiferes. iii. Fish management: activity diversification, technical improvement.	i. Show coherence between resource management and protection plans, improve touristic aesthetics, preserve marine ecosystems and biodiversity. ii. Value biodiversity and conservation. iii. Improve production and conservation.

Table 2.1 (continued)

3. Income opportunities, technical alternatives, and profitable commodities.	i. Establish testing and demonstration centers for the development of rainfed cultural systems, vegetable crops, and improvement of irrigated rice culture. ii. Pisciculture. iii. Watershed Management. iv. Natural forestry management (peripheral zone). v. Harvest of palm seeds. vi. Butterfly production. vii. Seedbed for plant production destined to the Zoo of Zurich. viii. Beekeeping. ix. "Raphia" and "Penja" exploitation. x. Ecotourism.	i. Improve productivity of crops (yield +20%) and diversification, convince farmers to adopt improved technologies, improve income and food with women in production, increase number of farmers in network, decrease "tavy" practices and cleared forests. ii. Improve deficit in animal protein with consumption, and income with sale, decrease hunting and pressures on ecosystems. iii. Value innovative techniques (from ICDP) adaptable to the site, effective land delimitation and behavioral change (collaboration with CIFOR and University of Madagascar). iv. Value forestry products on the international market by eco-certification with Woodmark. v. Improve income (seed market with Kew Garden and Palm Society). vi. Improve income with labor, promote ecotourism, master production techniques for reproduction. vii. Improve income. viii. Decrease pressure in protected area while improve income, contribute to agricultural production (pollinization). ix. Improve and diversify income, behavioral change towards natural resources. x. Improve income, participation of local community to conservation, behavioral change.

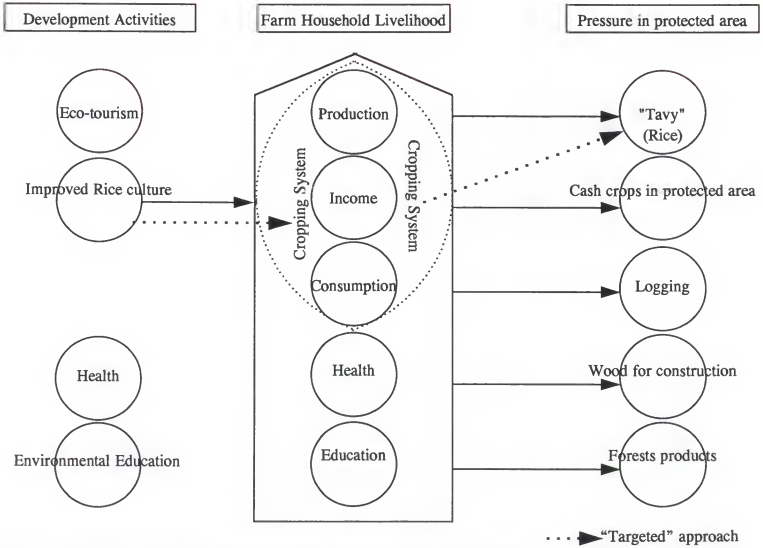

Figure 3.1. Schematic of debate on effects and impacts of development activities

CHAPTER 3
EVALUATING THE FARM HOUSEHOLD AND PROTECTED AREA: A LINEAR PROGRAMMING MODEL

One purpose of this research is to provide to managers of the Integrated Conservation and Development Projects (ICDP) in Madagascar a system of tools for evaluating, monitoring and managing socioeconomic development activities. Within the context of farm household potentials and capabilities, the resilience of the protected area, and the broad-based institutional environment, these tools will assist managers in clarifying the components and relationships in the conservation and development paradigm. They also will identify the determinant relationships among these different sets, facilitating managers' work in targeting groups and activities for the sustainability of the ICDP. ICDP managers thus can provide a vital link among international and national policy and decision-makers, program supervisors, and the project level farm households.

The tools proposed are designed to be operational, flexible, and manageable. The ex-ante socioeconomic evaluation system is a two-stage approach with: 1) the linear programming model (LPM) at the interface of evaluation, monitoring and management; and 2) the ICP evaluation model. This Chapter is focused on the LPM.

Linear Programming Model (LPM)

Swanson (1996) summarizes one of the main problematics of socioeconomic monitoring and evaluation of ICDP:

> we are presumably implementing certain development activities, at certain scales, in certain areas, with certain people, based upon some kind of expectation linked to project objectives.... In many cases, the expected impacts have not been thought out clearly enough for major activities to permit the kind of targeted monitoring necessary. Experience has shown that the "conservation" and "development" components of projects have operated independently of each other, like separate subprojects. The "development" has tended to be unfocused "regional rural development," and not within a clearly defined peripheral zone around the parks and reserves.... (p. 13)

This statement has been confirmed over the last few years in monitoring and evaluation meetings through harsh debates on why, what, and how questions on approaching the relationships between protected areas and farm households. On the one hand, proponents of a broad or general ("shotgun") approach argue that the systemic and dynamic nature of the farm household and protected area systems make it impossible to distinguish and narrow the effects of any one development activity on any one specific pressure. They contend that development activities also are systemic in their relationships, effects, and impacts among themselves, and on farm household and protected area systems. Thus, a targeted approach in the extreme would be quite unacceptable.

On the other hand, proponents of a specific or targeted ("silver bullet") approach argue that, when pressures and their causes are well-defined and understood, it is possible to test the hypothesis that a specific development activity affects positively farm

household livelihood and behavior, and decreases and/or ceases the pressure it was mainly designed for. However, no decisive methodology exists to test these hypotheses.

The objectives of the LPM are to clarify the components, or subsystems, of the protected area and farm household sets, identify the determinant relationships between them, and analyze alternatives to propose for problem resolution. In so doing, the "division" of the sets (Figure 1.2) into subsystems is helpful. Indeed, it is expected that when the identification and causes of each environmental pressure are specified, the pressure can be identified with a specific subsystem in the production, income, consumption, and/or other systems of the farm household (Figure 3.1). The LPM is designed to allow partial analysis of each subsystem containing a specific pressure. Subsystems can then be combined for more complex models.

As an example in the Masoala case, one identifies "tavy" rice culture as a main pressure. Tavy is an integral part of the farm household cropping system, the main subsystem in the farm household production system. Tavy touches production, income, if rice is sold, and consumption systems from its place in this rice-based cropping system. A "partial" analysis of the cropping system (model presented in this work) with and without tavy can be performed with the LPM. For a resource (personnel, equipment, capital, and the like) constrained ICDP, such partial analysis can prove useful for the managers in anticipating the effects of the decrease and/or cessation of the tavy on farm household welfare.

Introducing one or a package of "improved rice culture" techniques in the model, with and without tavy, would help identify appropriate development activity to introduce,

and provide insights into expected changes in the cropping system, and farm household livelihood with the development activity. This phase is not done in the present study because data are not yet available.

Suppose that activities in ecotourism are to be considered with the objective of increasing income and decreasing cash crops in the protected area. Cash crops are also part of the cropping system. Ecotourism activities will affect labor distribution, as well as allocation and use of resources in the cropping system, and thereby disturb the farm plans in production, income and consumption. Ecotourism activities can be inserted into the simulated farm model, and issues about farm household welfare, and alternatives and/or "technology" introduction can be analyzed. Situations with and without tavy and/or cash crops can be analyzed, as well as with and without improved rice culture and/or ecotourism activities, and so on. We can think of targeted blocks of matrical subsystems composed of activities and constraints that can be assembled and disassembled as needed without losing the essence of the whole system. More detailed and complex models are part of future research and not included in the present effort.

The particular case of Masoala ICDP illustrates the operationality of the proposed socioeconomic monitoring and evaluation system (SEMES), as a package of management tools for managers of the ICDPs. Thus, the case has no intent of studying or resolving at once all the farm system problems of the household. As an illustration, it is accomplished under stringent data constraints. Important as well is to keep in mind the resources and constraints at the ICDP field management level. Further complexity might

be achieved in the future as needed and desired with improved information, as linear programming possesses many flexible features.

The Basic Mathematical LPM

The LPM draws heavily from the basic mathematical model in Hazell and Norton (1986), and is adapted and applied to a relatively "average" Masoala farm household. It is acknowledged that farm household behavior, through its objectives, activities and constraints is much more complex than the model presented here. That is, the farm household forms its behavior from all the possibilities, resource requirements, and constraints it faces. The choice of activities, as well as allocation and use of resources, depends on household objectives and all of the activities and constraints present in the household. However, it is argued that prominent subsystems tied to predominant pressures, or vice versa, determine the farm household behavior and livelihood with regards to conservation.

$$\begin{gathered} Max\ Z = \sum_{j=1}^{n} c_j X_j \\ suchthat \\ \sum_{j=1}^{n} a_{ij} X_j \leq b_i,\ all\ i = 1, \ldots, m \\ X_j \geq 0,\ all\ j = 1, \ldots, n \end{gathered} \qquad (1)$$

Where:

X_j = the level of the j^{th} activity.

j = Rice: rice 1 produced (RI1), sold (RI1S), consumed (RI1C), purchased (RI1P); rice 2 produced (RI2), sold (RI2S), consumed (RI2C), purchased (RI2P); tavy produced (TAV), sold (TAVS), consumed (TAVC), purchased (TAVP). Subsistance crops: cassava produced (CAS), sold

(CASS), consumed (CASC), purchased (CASP); sugar cane produced (SGC), sold (SGCS), consumed (SGCC), purchased (SGCP); banana produced (BAN), sold (BANS), consumed (BANC), purchased (BANP); taro produced (TAR), sold (TARS), consumed (TARC), purchased (TARP). Cash crops: coffee produced (COF), sold (COFS), consumed (COFC), purchased (COFP); cloves produced (CLO), sold (CLOS); vanilla produced (VAN), sold (VANS). Cash flow: cash transfer from beginning year to semester 2 (CSH1); cash transfer from semester 2 to end year (CSH2).

c_j = value of a unit of the jth activity.

a_{ij} = quantity of the i_{th} resource required to produce one unit of the j_{th} activity: hectare (ha) for land; days (days) for labor; Malagasy Franc (Fmg) for cash; kilogram (kg) for the quantity of output produced, sold, consumed, and purchased.

i = Land: rice land (LdRI); tavy land (LdTV); land for subsistance crops (LdSBS); land for cash crops (LdCSH). Labor: January labor (LbJA); February labor (LbFB); March labor (LbMR); April labor (LbAP); May labor (LbMY); June labor (LbJN); July labor (LbJL); August labor (LbAG); September labor (LbSP); October labor (LbOC); November labor (LbNV); December labor (LbDC). Yields, consumption and purchase: rice 1 produced (RI1), consumed (RI1C), purchased (RI1P); rice 2 produced (RI2), consumed (RI2C), purchased (RI2P); tavy produced (TAV), consumed (TAVC), purchased (TAVP); cassava produced (CAS), consumed (CASC); sugar cane produced (SGC), consumed (SGCC); banana produced (BAN), consumed (BANC); taro produced (TAR), consumed (TARC); coffee produced (COF), consumed (COFC); cloves produced (CLO); vanilla produced (VAN). Cash: cash at beginning of year (CSH1); cash in semester 2 (CSH2); cash at end of year (CSH3).

b_i = quantity of the i_{th} maximum or minimum constraint.

Procedure

The use of the LPM to analyze various potential actions is based on first simulating existing representative livelihood systems. After a base model that adequately

simulates a given livelihood system has been created, it is then used to analyze alternatives by incorporating them into the base model.

Assumptions

The base LPM simulation concerns only the cropping system of the farm. According to the data available, this subsystem in the production, income and consumption systems of the Masoala farm household set appears to be the determinant of the farming system and the household's behavior. Other activities, such as livestock, fishing, and non-tavy activities in the protected area, can be included later as needed. A more complex model is possible and subject to further research. The present choice of production activities is also driven by the desire to understand the main pressure, tavy culture in the protected area, which can be thought of as an integral part of the farm's cropping system.

For purposes of linear programming, the most realistic objective of this type of farm household has been found to be to maximize annual discretionary cash available for spending, without violating any of the resource or consumption constraints (P.E. Hildebrand, personal communication). Annual discretionary cash available for spending can be thought of as the end of year cash balance minus beginning year cash balance. The cash balance is defined as that amount of money available for all other purposes, after production costs, food and other required uses for cash related to the subsystem considered (cropping system) have been deducted.

Building a complex model requires the understanding of each subsystem and the circumstances surrounding its presence in the farm household. Besides ranking pressures by severity in the protected area, it is argued that subsystems that determine the farm household livelihood also can be prioritized. This prioritization of the farm household subsystems allows partial analyses. The present model will provide a useful glimpse of farm household circumstances, and of the posssibilities offered by the model in relation to managing the SEMES for the ICDPs. Preliminary analyses, for example, can reflect alternative farm household circumstances resulting from the presence or absence of tavy in the cropping system, and from the diversification of farm activities.

The Data

The data are from the Masoala peninsula ICDP. Distributed in 4 watersheds, 167 Masoala farm households[1] were interviewed in the sample by the ICDP socioeconomic monitoring and evaluation team.

The cropping system can be categorized based on rice production, and the practice of rice tavy. Seven farm types (percentage given is over a sample of 153 farm households) can be delineated: 1) rice 1 only (17%); 2) rice 2 only (4%); 3) tavy only (11%); 4) rice 1 and 2 (21%); 5) rice 1 and tavy (33%); 6) rice 2 and tavy (8%); and 7) rice 1 and 2, and tavy (6%).

[1] The number of farm households actually interviewed was 167, of which 153 were chosen for the purposes of this analysis.

The base or simulation model for the present analyses is based on an aggregate "average" farm which corresponds to average farm type 5. Any type of farm can be examined however with this model.

This research has been performed with limited funding and scarce data. The data were sent from the Masoala ICDP, Madagascar, to the University of Florida, USA, with various time, logistical, and communication constraints. Inconsistent and incomplete observations were difficult to identify and correct in a timely manner for the present research. Secondary data were complemented with observations from key informants and other sources, including an Internet network of Malagasy scientists and students. Much of the complementary information comes from the author's personal experience and knowledge.

Analysis

Two models are utilized for the analysis. The basic simulation LPM includes rice 1 and tavy production and purchase of tavy is allowed. The alternative is production of rice 1 without that of tavy, and purchase of tavy is not allowed. Both models contain the same objective (maximization of annual discretionary cash income), activities (production, sale, consumption, and purchase of rice, subsistence and cash crops), and constraints (land, labor, cash, consumption).

Land is constrained to 1 hectare of rice 1, and 0.5 hectare of cash and 0.5 hectare of subsistence crops. No limit is put on tavy land exploited in the base model. Labor has been distributed on a monthly basis, and the amount is constrained to one adult male and

one adult female in the farm household, with half time available for production activities for the female. No hired labor is available. Cash available at the beginning of the year has been constrained to the amount needed to produce one hectare of rice 1.

Consumption is based on an average household size of 6 persons. Purchase is allowed for any 3 types of rice in the base model, but not for tavy in the alternative model. However in that later case, storage in rice 1 and transfer of rice 1 to rice 2 are allowed. Subsistance crops are either sold or consumed, and cash crops are sold only except some for coffee consumption. Prices were estimated by the author from available data to follow seasonal variations in rice: low prices in the normal season, high prices in the hungry season. Also selling prices are less than purchasing prices. Seasonal trends are realistic but the magnitudes should be interpreted with caution.

The Basic Simulation Model: Rice 1 and Tavy, and Purchase of Tavy Allowed

The results show that when tavy is allowed (Table 3.1), most of the rice 1 land is used, and all subsistence and cash crop land is used. In addition, 1.8 ha of tavy are exploited. Surplus rice 1 (normal season) is sold, 516 kg consumed, and no purchase of rice is made in that season. All rice 2 consumed is purchased. Tavy production compensates for the deficiency in rice 2, with 1.8 ha produced, a significant 700 kg sold, 258 kg consumed, and none purchased.

All subsistence crops including cassava (0.087 ha), sugarcane (0.1 ha), banana (0.27 ha), taro (0.04 ha) are produced and consumed, but only surplus banana is sold.

Table 3.1. Results of the basic simulation model with rice 1 and tavy.

Item	Unit	Rice 1 + Tavy	Rice 1 only
Rice 1 area	ha	0.974	1
Rice 1 produced	kg	789	810
Rice 1 sold	kg	273	0
Rice 1 purchased	kg	0	222
Rice 1 consumed	kg	516	516
Rice 1 stored	kg	0	516
Rice 2 area	ha	0	0
Rice 2 produced	kg	0	0
Rice 2 sold	kg	0	0
Rice 2 purchased	kg	258	0
Rice 2 consumed	kg	258	258
Tavy area	ha	1.807	0
Tavy produced	kg	958	0
Tavy sold	kg	700	0
Tavy purchased	kg	0	0
Tavy consumed	kg	258	258
Banana area	ha	0.27	0.27
Banana sold	kg	746	746
Coffee area	ha	0.264	0.5
Coffee sold	kg	241	468
Vanilla area	ha	0.236	0
Vanilla sold	kg	105	0
Available labor	days	75.1	197
Ending cash balance	FMG	2,524,810	1,623,676

No cloves are produced, while coffee (0.26 ha) is produced, and some sold and consumed, and vanilla (0.24 ha) is produced and sold.

Labor constraints exist in the months of April, June, and July, although all months, except January and August, are quite active though not binding. Less than 20% of total available labor is not used.

All food consumption needs are satisfied, and annual discretionary cash of FMG 2,524,810 (about US$ 631) remains for all other purposes to the farm household.

The model concerns only the cropping system of the farm, yet it is considered that this model adequately simulates the representative farm livelihood system against which to evaluate alternatives.

Alternative Model: Rice 1 Without Tavy and Purchase of Tavy is Not Allowed

The prohibition of tavy production and purchase in the cropping system (Table 3.1) would decrease the annual discretionary cash available for spending by about 35% from the original situation, to FMG 1,623,676 (about US$ 406) if no other sources of income were available.

All available cropland is used for rice 1, subsistence and cash crops. The farm household would have to purchase 222 kg of rice 1, and store 516 kg for consumption in the rice 2 and tavy consumption periods. Crop diversification would decrease because only coffee, and not vanilla or cloves, would be produced. Available labor would increase by more than double to 197 days.

Conclusion and Implications

Thus, everything else being the same, the farm household performs tavy culture for income, and to compensate rice consumption and purchase during the hungry season. A significant amount of land (1.8 ha of tavy for a 3.8 ha farm size) is devoted to the activity.

The prohibition of tavy production would decrease welfare and productive employment on the farm. If compensating income and other use for this labor were not found by alternative ICDP activities, the farmers might employ the available labor in other extraction activities in the protected area.

CHAPTER 4
A CONCEPTUAL FRAMEWORK FOR CONSERVATION AND DEVELOPMENT

Managers of the Integrated Conservation and Development Projects in Madagascar are confronted with the task of finding consensus and complementarity within the concerns for conservation and development. Many relationships and systems are at stake, most important being farm households in the peripheral zones and the protected areas.

Farm household behavior relative to production is motivated by concerns for security and survival. The assessment of farm level responses to changes in resource use policy, technologies and socioeconomic conditions can be studied as in Chapter 3. The present chapter is directed toward understanding the complex relationships, or overall environment, that confront farm managers and ICDP managers. It provides a basis for the institutional analysis to follow in Chapter 5.

The Basic Systems in the Conservation and Development Relationships

The overall conservation and development paradigm can be viewed as a grand system of relationships composed of subsystems called sets. Each set is a system on its own with subsystems. This chapter draws on Gunderson et al., (1995) and Kelly, (1995) for a paradigm to depict relationships in systems and subsystems, and their interdependencies (Figure 4.1).

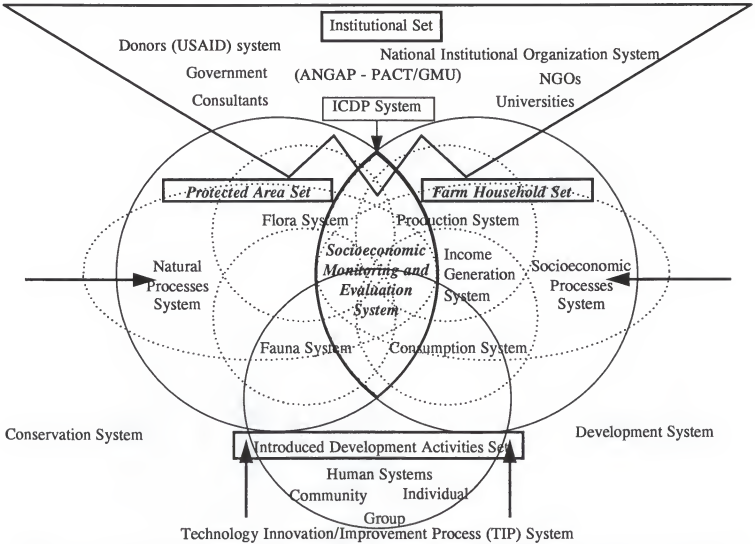

Figure 4.1. The grand system of relationships in conservation and development: The systems and subsystems

In this framework, the grand system of relationships is said to be sustainable when the synergy of the sets composing it maintains viability, durability and operationality in space and time. Some systems will work positively and others negatively toward sustainability. Since boundaries are necessary to distinguish systems, it is evident that some systems are of primary interest while many other systems and factors are relegated to a secondary status. From a management and socioeconomic monitoring and evaluation point of view, the systems and factors described are thought to be primary for sustainability within the conservation and development setting in Madagascar.

The conservation system. The protected area set which is a system composed of its fauna and flora subsystems is included in the conservation system. Endogenous (relations between and within subsystems and with their natural environment) as well as exogenous (natural processes such as cyclones, droughts, and/or other climatic processes) subsystems interact and influence the protected area system, and the fauna and flora subsystems. The socioeconomic subsystem also interacts with and influences the protected area through induced needs and motivations of the farm household in production, income and/or consumption. Resilience of biodiversity and ecosystems forms the main core within the conservation system.

The development system. This system contains the farm household set which is composed of its production, income and consumption subsystems. Endogenous (land, capital, labor, entrepreneurship, resource allocation and use, and productivity), as well as exogenous (prices, infrastructure, and socioeconomic processes) subsystems interact with and influence the farm household system and the production, income, consumption

subsystems. The natural processes subsystem also interacts with and influences the farm household system at the level of the production, income and/or consumption subsystems. Sustainability of productivity and profitability, as well as resilience of farm household systems, forms the main core within the development system.

The resilience in space (at a local, regional, and/or national level) and time (from season to year, and generation to generation) of biodiversity and ecosystems to natural processes and human behavior systems is at the heart of environmental sustainability. By the same token, the resilience in space and time of the human household system to natural and socioeconomic processes and systems is at the heart of human and development sustainability. The issues of resilience in space and time, and of linkages between sustainable conservation and development, bring forth the idea of introducing unique subsystems as development activities for farm households who exert pressures on the protected areas.

The development activities system. Substitute activities to reduce human pressure in the protected area are to be introduced to peripheral zone farm households. They constitute a system which can be viewed as a distinct set in the grand system of relationships. By introducing community, group and/or individual development activities to meet the basic needs of farm households, the ICDP expects that farm households will decrease and/or cease the exploitation of natural resources and biodiversity in the protected areas, and involve themselves in conservation. It is assumed and expected that an "ethical" sense of protection responsibility toward the protected area emerges within,

from and among farm households. The exploitation of "open access" resources therefore would be naturally and "democratically" prohibited.

For example, it has been shown in Chapter 3 that farm households practice "tavy" to satisfy their rice consumption needs in the hungry season. On the other hand, it is known that "tavy" degrades the environment. If "tavy" is to be decreased and/or ceased, then development activities to respond to the removal of "tavy" should at least compensate for production and consumption foregone from that crop. The removal of "tavy" also frees labor for other purposes, in particular for such introduced activities. Among other considerations for these activities to be successful, one therefore should take into account the activities level of incremental benefits and labor used. Coupled with environmental education, such activities are thought to help farm households cope with their circumstances in an environment-friendly manner.

For these reasons, most people assume these development activities must simultaneously "better" human welfare and decrease pressures and damages on protected areas. Introducing development activities can then be viewed as a technology innovation or improvement process (TIP). Formal stages of the TIP (Chapter 6, Figure 6.5) in an agricultural setting have been proposed by McDermott and Andrew, (1995). As applied to the ICDP situation, technology embedded in introduced development activities might be questioned as to technology/activity design or generation, testing and adaptation. Hence, technologies and corresponding activities must be responsive at the local level.

The beliefs, values and incentives of the donors, international and Malagasy institutional organizations, and ICDPs blend into an institutional set which acts as a

system directing and shaping the goals, objectives and actions towards the conservation and development systems. This is particularly true in setting the priorities among conservation and development issues and the introduction of development activities.

The institutional system. An important factor for the success and sustainability of the ICDPs is the institutional system. Hence, decision-makers, managers, field agents and households are expected to integrate their rationale about the conservation and development paradigm into shared, meaningful and operational goals, objectives and actions. All of these participants share to different degrees the goals of natural resource and biodiversity conservation, as well as socioeconomic development of farm households. In a related topic, Kiker and Putz (1997) suggest actors "share some sensed, partial, approximate and noisy information."[1] Information about conservation and development is, by nature, diverse. Participants may differ in the emphasis given to the design and implementation of specific activities as they relate to conservation and development.

The monitoring and evaluation system. As a set at the intersection of all of the above sets, the monitoring and evaluation system is where the ICDP evolves. It is conducted by the institutional organizations extending from donors to the ICDPs. The actual and future situations of the Malagasy ICDP result from an institutional dimension of change, itself resulting from the evolution of concepts built through evolution of

[1] "For both the agent and the principal, knowledge of the environment is partial and approximate; sensing of the environment and the agent's actions is partial and noisy; the dynamics of the environment can be only partially predicted; and the agent's execution of actions [in the forest] is not completely reliable.... The result is that the agent needs to maintain a degree of reactivity to meet its goals in [the] face of unpredicted environmental and labor related or social situations, and the principal needs to be assured that agreed upon strategic goals and plans are being met, at least to some degree, otherwise the basis of the [certification] system collapses" (Kiker and Putz, 1997, p. 43).

beliefs, values, and incentives in the conservation and development paradigm in Madagascar. The management of change focuses on the relationships among the different sets, that is the interdependence of all the systems and subsystems described above. One main "raison d'être" of the proposed socioeconomic monitoring and evaluation system (SEMES) is to "test" the hypotheses established in planning, and through implementation of development activities, for conservation and development. Again, the desire is that the well-being of the farm households will increase and the pressures on protected areas will decrease and/or cease.

Decisions, Goals and Strategies in the Grand System of Relationships: A Principal-Agent Paradigm

The earlier systemic framework illustrates that the introduction and nature of development activities tied to conservation mainly depend on the institutions. Receiving, adapting, and adopting the activities depend on the farm households. Within the institutional set, relationships among international (donors), national (government, DEF, ANGAP), and local (ICDP) organizations influence the goals, objectives, and strategies at the ICDP and field (protected area and farm household) levels.

A multi-level principal-agent relationship exists among the actors in the grand system of relationships. Goals and strategies span from the abstract to operational, and extend from the donor level through the international and Malagasy institutional organizations to the ICDPs and farm households, finally to have an impact on all relationships in the total system.

Donors provide funds to the Malagasy institutional organizations to carry out the conservation and development goals and strategies, with an emphasis on conservation. These donors rely on their governments (USAID) and/or the international community (World Bank) for policy direction. Malagasy institutional organizations, such as the National Association for the Management of Protected Areas (ANGAP) and the Direction of Waters and Forests (DEF), supervise and coordinate the ICDPs at the national level, with priority on conservation and development. They simultaneously depend on the donors and the Malagasy government in carrying their mandate. Many other organizations and individuals, such as universities, NGOs and consulting entities, with their own beliefs, values and incentives, enter this system at different levels for different purposes. They depend and rely on the donors, the national government, and/or the ICDPs in fulfilling their objectives. The ICDPs manage the protected areas on a short-term basis with a long-term view to conservation and development. Satisfaction of the goals and strategies of related international and national organizations, as well as farm households is the mandate of ICDPs.

The principal-agent paradigm in the ICDP context possesses some interchangeable features. For example, from a participatory approach perspective, the farm households would be the principal and the ICDP the agent when identifying, designing and defining the development activities. The reverse would occur when implementing and actually conducting the development activities.

This interchangeable feature can be extended to the whole institutional set. It is a looping feedback channel in the grand system of relationships. For example, at the

design and planning phase, donors would be the principal when providing funds to the agents, the Malagasy national organizations. During implementation, the principal-agent relationship reverses. Biological and socioeconomic information is the basis for request by the now principal Malagasy national organizations, and for readjustment and reorientation by the donors, now the agent. These features suggest systemic relationships and interdependencies among institutional actors in decisions, goals and strategies of the Malagasy ICDPs.

In the identification, design, and definition of development activities, farm households and communities request technical assistance and/or technology from the ICDP. The ICDP often transfers the actual activities without conducting any on-site preliminary research to test and adapt solutions to the local situations. That is, the site itself becomes a living laboratory where trial and error is allowed. This process forms the basis for adaptive ecosystem management.

In the same manner, funding requirements bias the priority, design, and implementation of field actions. This situation is best illustrated by the following observations:

1. Conservation and development are two distinct departments like two sub-projects (Swanson, 1995) at the ICDP level. The monitoring and evaluation unit is supposed to promote the links between them.

2. Monitoring and evaluation, as an integrated activity, is divided into three distinct "subsystems": the project, conservation and development.

3. The project and conservation indicators are abundant and precise at the ICDP organizational level, but incomplete and difficult to implement in the real world. The development indicators are mostly left to the discretion of the ICDP which experiences different influences from institutions and actors.

Such partition and imprecision in development lead to unfocused development activities. The situation in development becomes one where activities are subjected to the beliefs, values and incentives of the diverse and different decision-makers, managers and field agents. In other words, even though farm households and communities seek the satisfaction of precise needs, activities might not always respond adequately. Global goals and objectives are shared, but design and implementation differ due to beliefs, values, and incentives.

Harsh debates in socioeconomic monitoring and evaluation meetings illustrate the problem. It is therefore useful to understand the perspectives on conservation and development, and make a meaningful convergence, which will be "rationalized" and "operationalized" with the ICP evaluation model.

It is useful to keep in mind that donor representatives, as well as international and national institutional organization representatives, visit the protected areas and farm households from time to time. The ICDPs manage on a day-to-day basis. Monitoring refers to the short-term management of ICDPs, at most yearly, while evaluation refers to a longer period of management by donors and national institutional organizations.[2]

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[2] "**Planning** is (a) the choosing of mission and objectives and (b) the development of a course of action to achieve mission and objectives. It involves ex ante evaluation. **Monitoring** is the observation of a plan during implementation and the taking of corrective action. It involves ex-

Differences in Perspectives

Chapter 3 has shown clearly that farm households encroach the protected area by necessity due to constraints in resources, and socioeconomic and institutional environments: in a way, a question of survival! In such circumstances, ICDPs are faced with sustaining the resilience of both protected areas and farm households. The relationships between population growth, increasing gap between demand and supply of food and non-food items, and socioeconomic and political concerns focus government priorities. National and international commercial entities related to natural resources and biodiversity are concerned about productivity and profit from their use. International donors and "green" institutions rather aim at conservation of natural resources and biodiversity.

Conceptually, a moderate and probably realistic view of conservation and development would seek complementarity and integrate both extremes in the paradigm. Sustainable environmental management focused mainly on the conservation of resources must take into account those who depend on the resources for their livelihood. Likewise, socioeconomic development, focused mainly on increasing the production of goods and services, must take into account sustainability of the resources on which production and consumption are based (UNCED, 1992).

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present, continuous evaluation. **Evaluation** is the determination of the value of a completed plan and involves ex post evaluation." (McDermott and Andrew, 1995, p. D-4)

However, two extreme ideals should not be overlooked, as their "reality" drives many institutions and actors in the conservation and development paradigm (Raustiala and Victor, 1996; Lehr, 1992). The first views conservation as a chief priority; conserving the environment, including natural resources and biodiversity, is needed and necessary. Human heritage and ecosystemic philosophy respond to an intergenerational value of conservation. Population growth, poverty and destructive production behaviors, because of, and leading to, loss of productivity, are seen as the main causes of environmental degradation and depletion. Policing and rationing are the primary approaches to satisfying this conservation and development perspective.

The second view sees development as the main priority. Meeting the population needs and wants through socioeconomic development is needed and necessary. The poor are mostly the development targets because poverty and population growth impact negatively on the environment. It is proclaimed that there is no evidence for human production behavior having any detrimental effects on the environment when production is rationalized (Lehr, 1992). Mere value-judgements and normative thinking about environmental issues are seen by these development proponents as the main constraints to socioeconomic development. A free market paradigm is the resolving approach, where market forces lead to "natural" equilibrium.

An array of common alternative views exists among these perspectives, giving more weight to one or the other.[3]

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[3] "Faced with the partial understanding we have of the problems and with the conflicting views of science, it is no wonder that public concern and mistrust are great but public understanding disturbingly bad. Political responses have a weak foundation for confident action

Blaikie and Jeanrenaud (1996) state "biodiversity and human welfare are perceived differently by a wide range of actors (international, national and local levels)." (p. 1) They define biodiversity as "the variability of life in all forms, levels and combinations within and among ecosystems, species and genetic material." (p. 3) The causes of loss of biodiversity are well documented, but estimates of loss are uncertain, deriving from extrapolations and estimates. Blaikie and Jeanrenaud summarize five general reasons for the importance of maintaining biodiversity: ethical reasons, maintaining ecosystems, material and economic benefits to people, maintaining evolutionary processes, and aesthetics. They express these in turn in terms of values which can be summarized as 1) direct and instrumental/use values comprising (a) non-market oriented consumptive use values and (b) market oriented productive use values, where conversion of value may exist between (a) and (b); 2) indirect instrumental/use values comprising (a) functions and services of ecosystems having value for society as public goods and (b) option values for present and future uses for direct and indirect values; and 3) non-instrumental intrinsic value related to moral responsibility.

As well as for biodiversity, human welfare means different things for different people as shown by the increasing range of sophisticated measures of welfare such as UNDP's Human Development Index (HDI). They show that different groups have

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that will not make the cure worse than the disease. To whom can the public turn for insight? This is less a problem of trust in science than of trust in governance by all participants who, in the absence of firm foundations for understanding, are forced to shape their decisions by beliefs" (Holling in Gunderson et al., 1995, p. 14)

"Understanding the bases of attitudes among the various publics he deals with can be helpful to the wildlife manager who faces a great challenge in coping with the conflicting views expressed, and politicized, concerning wildlife issues today." (Gilbert and Dodds, 1992, p. 49)

differing scales of influence, sources of power, interests and aims, and means of dealing/relating with biodiversity to reach interests and aims. From the range of local farm households to international groups, the scale of influence increases in scope. According to the authors, the power held by farm households is considerably less than that imposed by international groups concerning "green conditionality." Interests and aims range from livelihood maintenance and use of protected areas for subsistence needs by farm households, to commercial profit among entrepreneurs and tourism entities, and finally to conservation as expressed by international groups. Thus, depending on the actors, welfare can take a wide range of meanings.

Duraiappah (1996) points out that "until recently, there has been very little in-depth coordinated empirical research in the economics of environmental degradation-poverty causality relationships." (p. 1) He suggests the existence of a large degree of subjectivity about environmental degradation based on the actors, ecosystems and values involved relative to the particular resources of concern. He proposes ecological thresholds based on physical characteristics and revealed preferences as indicators of environmental degradation.

Defining poverty, the author summarizes three measurements: 1) the World Bank's household expenditure approach giving a poverty line threshold level; 2) the UNDP's Human Development Index (HDI) drawn from criticisms about the concepts of objective needs in the poverty line measure; and 3) a more encompassing approach relating to resource accessibility and the vulnerability of "low income groups who face high income uncertainty because of natural resource degradation." Accessibility and

vulnerability are based on more subjective needs than the objective ones in 1) and 2). Duraiappah distinguishes "indigenous poverty as caused by environmental degradation" from "exogenous poverty as caused by factors other than environmental degradation." He provides an analytical framework for literature review where causality relationships (Figure 4.2: R1, R2, R3A, R3B, R4, R1FB) between poverty and environmental degradation are postulated. "The relationships are not mutually exclusive and can be present simultaneously."

From a philosophical and practical management perspective, Gilbert and Dodds (1992) categorize people's attitudes and values toward wildlife as "economic (or commercial, including recreational), socio-cultural (including aesthetic), ecological (including biological), and scientific." (p. 54) They identify many factors affecting people's opinions, attitudes, values and incentives towards wildlife, such as occupations and professions, land ownership, immigration status, degree of dependency on wildlife, degree of contact with wildlife, sex, age, income, education, residency, ethnicity and religion. In sum, social, economic, cultural and political experiences and sense of belonging build one's own concepts, norms, beliefs, values, and incentives relative to the issues of conservation and development.

For example, biological scientists and ecotourists might be perceived by Gilbert and Dodds to place high values on conservation; social scientists and farm household members might be perceived to value development much more than conservation. Further, in a subsistence economy, the traditional sociocultural environment induces the farm household members to give more weight to conservation, because the household

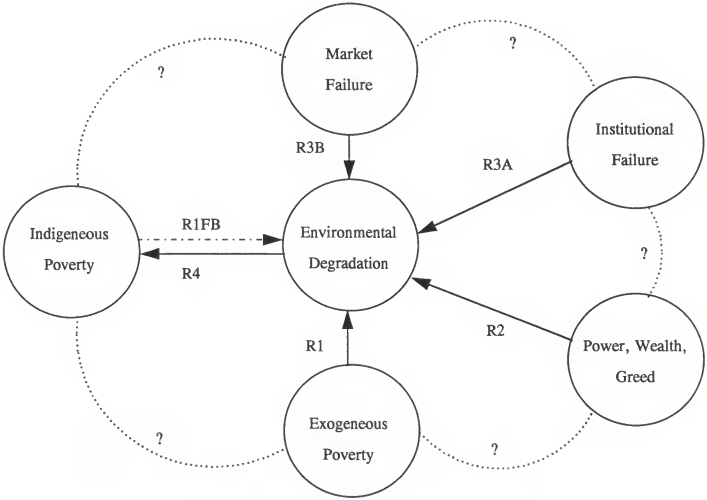

Figure 4.2. Poverty and environmental degradation

Source: Adapted from: A. Duraiappah, 1996.
Poverty and Environmental Degradation: A Literature Review and Analysis

depends on its immediate environmental resources for survival. Open markets and infrastructure bring exogenous socioeconomic development concepts based on material manufactured goods that disturb the traditional sociocultural environment, inducing the farm household member to give more weight to socioeconomic development.

Equally, a group of individuals or population sets, be it a community, society, country or international region, embodies aggregate beliefs, values and incentives resulting from those of its members. For example, because of science and media awareness, developed countries lean towards protecting the environment from depletion and degradation. Donors, originating from developed countries, and most importantly in-country executing ranks, have corresponding beliefs, values and incentives embedded in aid and assistance. Developing countries, because of population growth, poverty and "destructive" production behaviors, tend to give weight to socioeconomic development. Thus, developing countries tend to foster beliefs, values and incentives relative to their own goals that engender specific perspectives of aid and assistance (Lehr, 1992; James, 1994; Raustalia and Victor, 1996).

From yet another perspective, Holling (in Gunderson et al., 1995) suggests five belief systems in conservation and development which "are driving present debate and public confusion. Each reflects different assumptions about stability and change...." (pp. 14-15):

1. the view of "Nature Cornucopian is one of exponential growth" with endless resources, assuming human creativity for substitutes is able to cope with the gradual changes of nature;

2. the view of "Nature Anarchic is hyperbolic" where growth attains a limit followed by a decline, assuming the inability of humans to deal with their own creativity;

3. the view of "Nature Balanced is of logistic growth" where environmental and development sustainability are of simultaneous concern, assuming systemic relationships;

4. the view of "Nature Resilient is one of nested cycles organized by fundamentally discontinuous events and processes" comparable to schumpeterian economic business cycles and creative destruction, assuming shocks and waves disturb growth trends; and

5. the view of "Nature evolving is evolutionary and adaptive" where integration is the foundation, assuming a multidisciplinary perspective to the conservation and development paradigm.

Obviously, the diverse, practical to abstract, perpectives reviewed so far, leading to as well diverse beliefs, values, and incentives toward conservation and development, affect the grand system of relationships through institutional organizations and actors. ICDPs at the field level take into account the beliefs, values and incentives of donors, international and Malagasy institutional organizations, scientists, local communities and farm households. On the other hand, the field level where the ICDP evolves can be situated within the context of a broader environment where all institutional organizations and actors interact.

The grand system of relationships evolves in the broader environment which influences and is influenced by the grand system (Figure 4.3). The broader environment

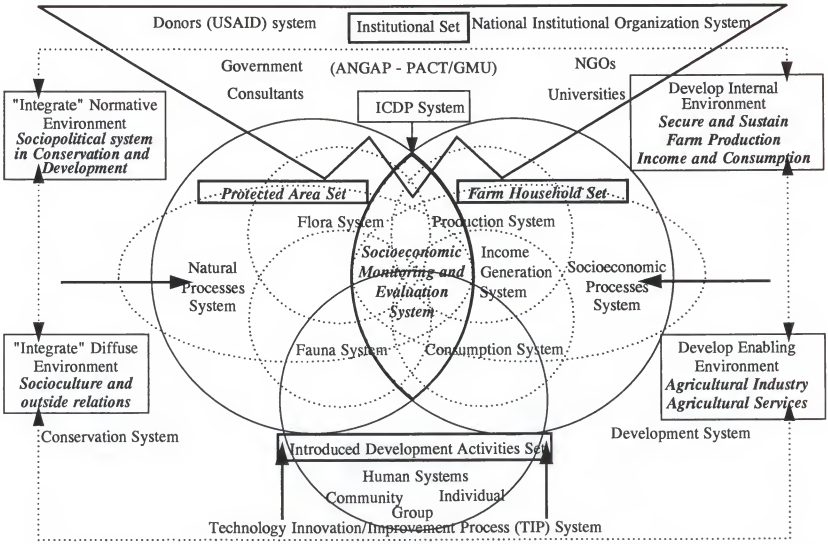

Figure 4.3. The grand system of relationships in conservation and development: The environments

can be characterized into four types of environments (McDermott and Andrew, 1995, pp. IX-3 to IX-5):

1. The internal environment of the ICDP system is composed of its own ICDP organization-entity, and the individual and units that make it into an operating entity. The objectives in the internal environment are to secure and sustain farm production, income and consumption so that pressures in protected areas will decrease and/or cease.

2. The enabling environment is composed of institutions and organizations that provide resources and authority" to the success of ICDPs. These institutions and organizations are included in the institutional set, such as donors. But they exist also outside the grand system, such as agricultural industry and services, and infrastructure. Hence, new or improved technology in introduced development activities often requires infrastructure and markets for inputs in production, as well as for product sales and income absorption.

3. The normative environment "includes those institutions that defend the norms and values of society.... They speak to moral concerns and ethical consequences of [ICDPs]." Sociopolitical forces at the local, regional, national and international levels, inside and outside the grand system of relationships, interrelate, interact and often conflict at the ICDP level. The normative environment often influences mission, strategies, planning and actions.

4. The diffuse environment "is composed of organizations that help form the general image of the institution and distribute information on its performance and achievements." Inside the grand system of relationships, the institutional set helps ICDPs

in such roles. Farm households as individuals, units and community also communicate among them about ICDPs, as do local, regional, national and international media.

At the ICDP field level, the beliefs, values and incentives of decision-makers, managers, field agents and farm households are "inputs" that feed into ICDPs in the grand system of relationships. These inputs also play a role in the formation of, and interactions with, the four different environments, which in turn may control or condition the success of ICDPs, e.g. infrastructure and markets. At the same time, most of these environments are also external to the grand system of relationships. Yet, they also feed "inputs" into the grand system by directing and shaping the goals, objectives and actions towards the conservation and development systems, in particular the introduction of development activities at the field level.

Because of such diversity in institutions and actors, resulting in disparity and imprecision in concepts and causal relationships about the conservation and development paradigm, it is argued that the efficiency, success and sustainability of a SEMES of ICDPs depends on interrelations, linkages and synthesis of beliefs, values and incentives of the different institutions and actors at different levels of decision-makings[4]. The ICP evaluation model is a tool and methodology where a framework is set, and actors input

[4] "Donors may not be referring to "funding" sustainability, but rather developing behavior changes and activities which local people can adopt which will lead to sustainable use of natural resources.... This is a long-term objective, and donors generally have short-term funding horizons.... We have learned that multiple "operators" do not lead to good management of program activities.... Maintenance of institutional identities and unique "approaches" seems to be at the core of the problem.... We have also learned that multiple donors pose problems for coordination and management of development activities in a peripheral zone...." (Swanson, 1996, pp. 19-20)

beliefs, values and incentives. A synthesized shared and operational "direction" is then obtained.

The concepts and causal relations that build from the conservation and development paradigm and the grand system of relationships may raise some ethical, equity and sustainability issues closely tied to diverging beliefs, values and incentives.

Ethics, Equity and Sustainability

Ethics and equity issues stem from both the conservation and the development conceptualization of sustainability. From environmental and human perspectives in a grand system of relationships, sustainability requires that the needs and derived activities of the present generation do not compromise the satisfaction of the needs of future generations relative to resource, production and welfare opportunities. The time scale of sustainability is rather vague. We cannot determine or bound the end of all life, nor can we predict the unforeseen future changes in ecosystems or household systems.

Resilience of the protected area and farm household systems is a key component in the intergenerational concern for sustainability. The use of renewable and nonrenewable resources must be sustainable. This is particularly true for the resources required for development, including development activities to be introduced to farm households. Also, population growth, and corresponding derived needs and activities, factor into this sustainability situation.

Gill (1991) has provided an extensive appraisal of the climatic, biological, infrastructural and technological natures of seasonality within year and their negative

impacts on the allocation and use of resources in agriculture in the developing world. Such factors are very important to the well-being of Malagasy farm households. Frankenberger (1985) has emphasized that the hungry season is a difficult period for the nutritional well-being of low-income farming households, trapped in a cycle of poverty. Further, Sahn (1989) has shown that year-to-year seasonal variability in Third World agriculture affects food consumption, food security and nutritional status. He has asserted that the major causes are fluctuating market prices and real income (cash and/or in kind), savings (stocks, livestock and/or cash), and food consumption behavior. These conditions are present in both rural and urban areas. Food insecurity in either or both rural and urban households occasioned by seasonal variations and seasonality have impact on sustainability of socioeconomic development in Madagascar.

To deal with seasonal variations and seasonality, high-input-agriculture for example might increase productivity, production, income and consumption for the farm household. But it might also perversely affect the environment. Ecotourism low-input activities, such as handicraft and tour guiding, might also increase income. Because of ecotourism, less time would be devoted to agricultural production, resulting in low-input-agriculture, and thereby induce more dependency towards food and non-food imports. From the perspective of the comparative advantage paradigm, which assumes a fair and sustainable exchange setting, ecotourism could be the solution to the conservation problem. However, risk from major economic fluctuations or natural disasters might jeopardize the livelihood system of people who shift their living practices and economic

enterprises from agriculture in expectation of high and consistent returns from ecotourism.

Further, the concept of affluence with economic growth viewed through gross domestic product in developed countries indicates a strong correlation with climate change and environmental degradation (MacKenzie and MacKenzie, 1995). Also, wealth creation through history, characterized by overconsumption in the developed world, shows that developing countries are left in a state of impoverishment, characterized by underconsumption, mass poverty and high population growth. It would appear then that the goal of extending prosperity through technology transfer and/or monetary programs from the developed to developing countries claims that the concept of economic growth, embedded in the conservation and socioeconomic development paradigm, must specify clear definitions and expectations about development activities for ICDPs.

In other words, "development activities" intrude on the traditional, indigenous Malagasy farm household system with concepts and practices of the modern capitalist market system. This situation leads to a structural transformation, "good" or "bad," at the household level in economic, social and cultural production and organization. Dualism paradigms, such as modern vs. traditional, industrial vs. agricultural, capital vs. precapital, cash vs. subsistence, urban vs. rural, complicate further the issue, nature and impacts of development activities (Hayami and Ruttan, 1986).

On the other hand, it may be possible that enforcing a preservation-protection model (Barbour et al., 1992, p. L-3) which restricts, through isolation and absolute protection, the access to protected areas from surrounding farm households, might

succeed for a while in conservation. But the existence of needy populations, and the required management response to establish an operational program, place in question the sustainability of such a model. The preservation-protection model argues that organizations and institutions, other than those dealing with conservation, might take care of socioeconomic development issues. The model is questioned in reference to the possibility and efficiency of separating the conservation and development issues in the Malagasy poverty context.

The systemic, adaptive, and principal-agent approaches to the conservation and development paradigm show the diversity and complexity of beliefs, values, and incentives that ICDP must deal with in its environments and in carrying out its mission in the field. Resulting diverse perspectives raise ethical, equity, and sustainability concerns about development activities to be introduced. Imprecision and confusion, and sometimes conflicts, about these beliefs, values, incentives, and perspectives render ICDP management inefficient, and to the extreme controversial.

A convergence in apprehending concepts and relationships in the conservation and development paradigm appears necessary for ICDP efficiency and management considerations.

CHAPTER 5
SOCIOECONOMIC EVALUATION MODEL

The Institutional Cognitive Pattern

The people of Madagascar hold perceptions from experience about living from day-to-day and year-to-year within a local to global environment. They relate to nature and each other in complex ways, and may not always agree with those who grant assistance. Adding to the complexity, local, national and international institutions also relate to the issues of conservation and development in different ways. From the standpoint of the grand system of relationships involved with conservation and development in Madagascar (Figure 4.3), shared (though imprecise) concepts, perceptions, and ways of addressing needs and aspirations are depicted. The system leads to missions, strategies, causal relationships, and actions of institutional organizations and actors in the integrated conservation and development paradigm. Actual convergence of concepts and causal relationships toward design and implementation of conservation and development activities and actions may or may not exist, but is needed. The present research deals directly with concepts and causal relationships.

The planning, monitoring and evaluation work of the ICDPs is conducted by the institutional set (donors to ICDP) in the grand system of relationships (Figure 4.3). The management of changes could be traced with the institutional cognitive pattern (ICP)

based on fuzzy cognitive map (FCM) theory and neural network algorithm (Kosko, 1986, 1988, Taber, 1991), further developed by Fajardo (1993). Such a methodology relates the institutional dimension of change directly to the SEMES which focuses on the relationships between the rural household and the protected area; that is the intersection of all systems and subsystems in the grand system of relationships confronted by the ICDP. Identifying the concepts ("nodes") and causal relationships ("edges") in the ICDP systems constitutes a foundation for the SEMES. In so doing, it applies the basis of the institutional cognitive pattern methodology and analysis, the "signed digraphs (directed graphs) of a fuzzy nature with feedback." (Fajardo, 1995, p. 49-61, Kosko, 1985, 1988, Taber, 1991)

The Model

The ICP evaluation model is based on information about the ICDP system, and conservation and development, collected from various sources. Information is drawn from works done in Madagascar, especially from Richard Swanson (1995, 1996), an institutional-technical advisor to the Malagasy National Association for the Management of Protected Areas (ANGAP), and from the extensive and detailed multidisciplinary survey conducted by Russell Barbour et al., (1992).

Concepts and relationships are depicted from such sources to provide a signed digraph with feedback which expresses and simulates causal relationships under various circumstances. Figure 5.1 shows such a signed digraph with feedback for the Malagasy

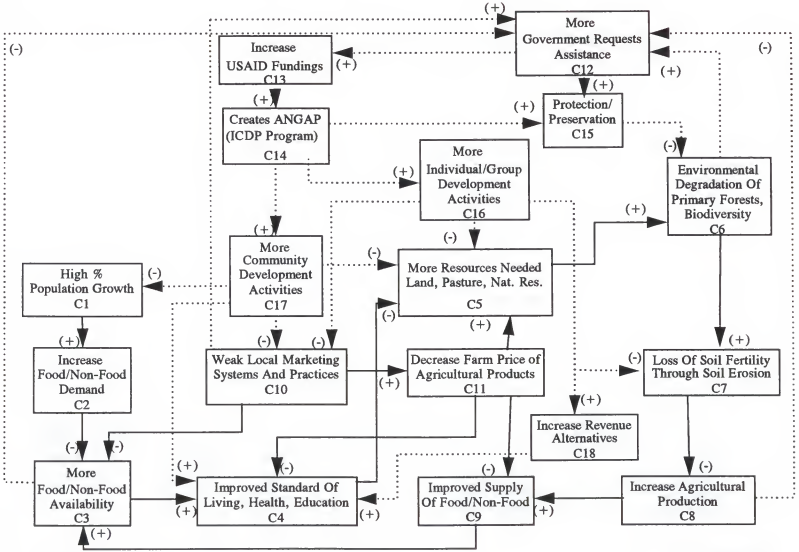

Figure 5.1. Signed digraph with feedback for Malagasy ICDP

ICDP. It traces the traditional system and an ICDP system with a conservationist model. The concepts are the numbered Cs, while the arrows and signs are the causal relations from C_i to C_j. A positive sign supposes that C_i will increase C_j, while a negative sign supposes that C_i will decrease C_j.

The Traditional System

Population growth (C_1) increases food and non-food demand (C_2), which decreases food and non-food availability (C_3). When more food and non-food items are available (C_3), farm household standard of living, including such domains as health and education (C_4) is improved. Improved farm household standard of living, including health and education (C_4) is thought to induce a decreasing use of resources (C_5). It is the increasing needs in resource use (C_5) that cause environmental degradation of primary forests and biodiversity (C_6). An important implication is that environmental degradation of primary forests and biodiversity increases secondary vegetation for the farm household subsistence base. Degradation of primary forests and biodiversity itself (C_6) increases secondary vegetation through mainly slash and burn practices, and increases the loss of soil fertility through soil erosion (C_7), which impacts negatively on agricultural production (C_8). If agricultural production (C_8) is not increasing, greater pressure from (C_8) to (C_9) to (C_3) to (C_4) will increase the resources needed for production such as land (C_5). However, increasing agricultural production (C_8) increases the supply of food and non-food items (C_9), which increases their availability (C_3). In a setting of weak infrastructure, weak marketing systems and practices (C_{10}) decrease food and non-food availability (C_3), but

at the same time decrease farm prices of agricultural products (C_{11}). Decreasing farm prices of agricultural products (C_{11}) has negative effects on standard of living, health, and education (C_4), while at the same time decreasing supply of food and non-food items from farm households (C_9), and increasing resources used (C_5), especially in the protected area.

The ICDP System

Environmental degradation (C_6) and decreases in food and non-food availability (C_3), as well as decreases in agricultural production (C_8), create requests to the government (C_{12}), which seeks outside assistance (C_{13}), as well as conducts actions, including policing, for protection and preservation (C_{15}). Funding agencies (C_{13}) respond to government (C_{12}) by creating an institution (C_{14}) to conduct conservation and development activities (C_{15}), (C_{16}), and (C_{17}), destined to curb targeted bottle necks (C_1), (C_4), (C_5) (C_6), (C_7), (C_{10}), and (C_{18}), in the conservation and development paradigm. Thus, the goal is to establish sustained integrated conservation and development.

Analysis

Approaches

The protection-preservation approach (C_{15}), including policing, relies on other institutional organizations and approaches, such as integrated rural development, to solve the development problem of the farm household system. Individual-group-community development activities exist but are not directly tied to the problem of conservation. In

that sense, the relationship between the improvement of standard of living and resources needed is not really addressed, as no connection is made between demand and supply of food and non-food items. Protection-preservation activities are assumed by enforcing agencies to motivate people to find other sources than protected areas to meet production, income and/or consumption needs.

In the ICDP approach, people are induced to improve resource allocation efficiency and to increase productivity and profitability through individual-group-community development activities brought about by ICDP. In other words, increasing food and non-food deficit, declining agricultural production, and environmental degradation increase the demand from farm households to government, which in turn calls for assistance to conduct development activities.

Example of Tavy in the Masoala Case Study

The environmental pressure of tavy (slash and burn) has been identified by the Masoala ICDP team as the primary pressure in the protected area (C_6). This research identifies the cropping system as the determinant subsystem in the livelihood system (C_8, C_4) of peripheral zone farm households around the Masoala protected area. Tavy is directly tied to, and is an integral part of, the cropping system. Removal of this practice, as specified in the linear program analysis (Chapter 3), would be very difficult for Masoala farm households.

In the signed digraph of Figure 5.1, a protection-preservation policy (C_{15}) alone does not answer the need to substitute a viable alternative for tavy in the farm household

livelihood system. Indeed, it has been shown (Chapter 3) that prohibition of the tavy practice decreases dramatically the well-being of farm households, measured in terms of annual discretionary cash spending. In the absence of substitute alternatives as responses to the need for more resources (C_5) to replace the supply of rice foregone from tavy (C_9), while also removing environmental degradation (C_6) and the increase of secondary vegetation, it is expected that farm households would bypass the preservation policy if possible. Socio-political problems might arise to further confound the socioeconomic issues. It becomes an ethical and equity issue that farm households be given compensation for sacrificing their livelihood for the well-being of humanity.

The introduction of development activities (C_{14}, C_{16}, C_{17}) under the ICDP model brings with it other causal relationships (noted as discontinuous arrows). The rationale of the ICDP development strategy is, in a sense, to disturb the "traditional" setting (in continuous arrows) by introducing "improved" environment-friendly activities, technologies and/or technical processes (in C_5, C_7, C_{10}, C_{18}) directly tied to the pressures and designed to reduce environmental decline. Again, it is assumed that introduced development activities "better" the rural household system. The incremental gain with the improved system will compensate or exceed directly the loss from the "traditional" system, particularly in the use of natural and biological resources in the protected area. It follows that introduced individual-group development activities are socioeconomically and culturally "better" than "traditional" activities.

Thus, the types of development activities to introduce in farm household systems must be tied closely to the types of environmental degradation in protected areas. By the

same token, these development activities are assumed to take care of market-infrastructure-institutional failures. Further analyses might be needed when considering such issues more closely.

Beyond the Masoala Case Study

Prioritization of pressures is expected to help identify the types of development activities which directly address these pressures and their causes. It is thought that if the individual-group-community development activities are directly tied to the problems in the protected area system and their causes, then rural household welfare will improve and human pressures on the protected area will decrease and/or cease.

It is obvious in this conceptualization of an institutional cognitive pattern for Madagascar conservation and development paradigm that it is not enough to simply increase goods for the needy. Indeed, population growth is also a cause of the problem, as well as market and institutional failures. It is assumed that community development activities, such as improving human health, family planning, education about the environment, and farmer organization are simultaneous requirements with individual and/or group economically oriented development activities.

Other assumptions are embedded in this framework. Development activities induce market and infrastructure availability to provide inputs and food, non-food, income and other goods and services, and absorb outputs and income earned from production. A more subtle assumption is that markets and infrastructure will integrate the rural household into a market economy with free and open access, in place of the subsistence

economy. This will decrease the tendency toward self-sufficiency and increase interdependency in the exchange economy based on money and "balanced" income distribution. In this reasoning, the money-based economic system (in continuous and discontinuous arrows) will form new cycles, breaking the vicious circle of poverty and environmental degradation in the traditional system, and lead to a new form of development. That is, if the individual-group-community development activities are tied directly to environmental degradation and directly address its causes, resources needed for production will be stabilized by market and infrastructure, thereby decreasing environmental decline. This of course assumes that market cycles will not become so pronounced as to force farm households back to tavy practices as the source for their livelihood.

Conclusion

The ICP evaluation model as an ex-ante evaluation tool intends to improve:

1. the design, consistency, focus and implementation of conservation and development programs;

2. the assessment of interactions among the different environmental, socioeconomic and developmental factors;

3. the bases for decision-making at all levels;

4. the self-regulating potential for sustainability of integrated conservation and development systems;

5. the chance that resource utilization increases farm household welfare and reduces negative impacts on natural resources and biodiversity in protected areas; and

6. the information needed for the formulation and selection of sound conservation and development policies in the decision-making process.

An institutional cognitive pattern methodology and analysis for Madagascar conservation and development paradigm can act as an ex-ante evaluation tool. For the ICDPs, it will focus on the evolution of concepts and derived strategies resulting therein as well as the expected impact of changes in the concepts and strategies. It can be carried out in a form of workshops involving the actors from donors to ICDP, where LPM and STAT are bases of discussion, and expected outcome is a "consensus" on direction and intervention focus.

CHAPTER 6
SUMMARY AND FOUNDATIONS OF A SOCIOECONOMIC MONITORING AND EVALUATION SYSTEM FOR THE ICDP IN MADAGASCAR

An Integrated Monitoring and Evaluation System

The "direction" of Malagasy ICDPs is to integrate conservation and development systems into a sustainable overall system for the resilience of present and future farm households, as well as of protected areas. Planning and implementation can facilitate progress in the direction of achieving the dual goals of conservation and development in Madagascar, and help maintain direction toward integrated programs. Maintaining "a sense of direction" in the ICDPs is the task of carefully designed and implemented monitoring and evaluation efforts, e.g. its "raison d'être." A depiction of the challenge might involve ex ante and ex post evaluations (along with monitoring) as "nested mirror images," where desired results and impacts constitute the setting of direction (Figure 6.1). Situation analysis, mission and strategies are the basis for the expected impact. Thus, the grand system of relationships (Figure 4.3) requires consideration of complex forces, comprising socioeconomic needs and objectives, and environmental conservation.

As stated by Swanson (1995), the Malagasy ICDPs' mission (goal and purpose) is "to establish sustainable human and natural ecosystems in areas of Madagascar where biodiversity is threatened, by identifying and establishing sustainable systems, including

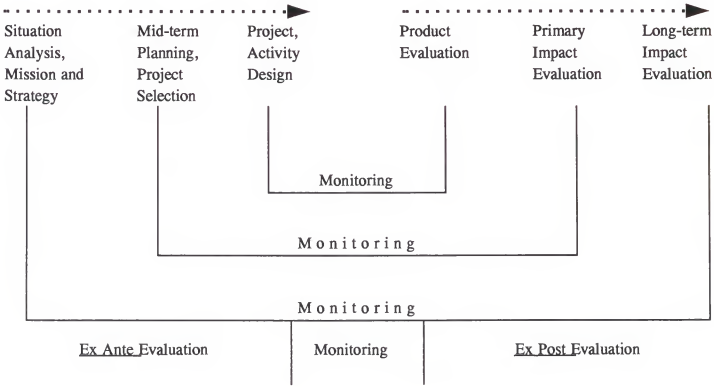

Figure 6.1. Planning - monitoring and evaluation model

Source : McDermott and Andrew. Agricultural Program Management. 1995. University of Florida.

institutions, methods, and behavior for management of protected areas of Madagascar and their peripheral zones." (p. 1)

The situation in Madagascar is that poverty and degradation of protected areas are closely related (Barbour et al., 1992; Swanson, 1995, 1996; Kremen, 1997). Agriculture is the most important source of socioeconomic growth and employment for farm households in peripheral zones and the country as a whole. Insufficient supply and low incentives in price structure of agricultural products for seasonal consumption and income earnings lead farmers to exploit the protected area under different forms. Rice production by "tavy" (slash and burn) practice has been illustrated in chapter 3 as a compensating activity for the farm household in the hungry season.

Simultaneously, natural resources in protected areas and socioeconomic development of those farm households in the peripheral zones must be managed efficiently if the system is to be sustained.

The environment in which individuals function is formed by legal, political, cultural, economic, and social institutions. Institutions and their organizations, such as the ICDPs, are human arrangements that "condition" individual behavior (McDermott and Andrew, 1995, pp. IV-1 - IV-21). These institutions, springing from the groups, collectivities and/or society itself in Madagascar, provide incentives and disincentives to Malagasy decision-makers. Farm families in Madagascar respond as rational decision-makers determined to survive, which is not a failing trait. A result, however, is environmental degradation. This situation gives context to Duraiappah's (1996) conclusion that institutional (and market) failure causes environmental degradation.

The strategies of the Malagasy ICDPs are to conduct conservation activities in protected areas, and introduce development activities into the peripheral zones. Farm household systems in the peripheral zones are the targets for development activities. Development activities in turn are expected to help conservation activities (Barbour et al., 1992; Swanson, 1995, 1996; Kremen, 1997).

Planning and project selection, including the sequence of activities, provide the route to achieving the mission, where primary impacts are expected to lead to long-term impacts. The project and activity design provides the products that encourage realization of specified long-term impacts. "Hypothesis testing"[1] in both general and specific ways, where introduced development activities are pilot activities and/or trials, is an approach to maintain direction toward the mission and strategies of Malagasy ICDPs. The ICDP approach asserts a clear linkage between conservation and development activities, thus focusing on integrating sustainable human and natural ecosystems in areas of Madagascar where biodiversity is threatened (Swanson, 1995). Poverty and environmental degradation possess two-way relationships where causality and determining factors need to be tested.

Evaluation is continuously present through the "direction process," and it determines progress toward products, as well as primary and long-term impacts. Monitoring occurs during implementation, and it verifies the progress toward planned activities (McDermott and Andrew, 1995, pp. D-1, D-2). A socioeconomic monitoring

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[1] "General ICDP Hypothesis: Economic development activities, linked to the conservation objectives of protected areas, will produce benefits which attract and focus the productive forces of a local population into sustainable and environmentally sound activities." (Swanson, 1995, p. 1) Specifically, each introduced development activity must address a specific principal human pressure that threatens a protected area, with the objective that the activity will promote human livelihood and diminish such pressure.

and evaluation system (SEMES) in the Malagasy ICDPs provides management tools for ANGAP as a coordinating body and for each ICDP as field operator (Swanson, 1995, 1996). It helps in setting a course of activity and in maintaining direction through hypothesis testing. The SEMES is based on determining and verifying the value of development activities in achieving sustainable human and natural ecosystems in Madagascar. The value of development activities is defined through concepts and relationships in an evaluation system, leading to socioeconomic indicators in a monitoring system. The socioeconomic monitoring and evaluation system (SEMES) is composed of two stages:

1) The evaluation system proposed is performed both at the level of the farm household and the institutional set (Figure 4.3). It is composed of (i) a linear programming model (LPM) which helps understand the farm-level short-term (annual) impact of various policy issues, and also serves an important role in evaluation by providing feedback to the ICP where socioeconomic policy actions are taken to achieve long-term goals, and (ii) an institutional cognitive pattern (ICP) methodology and analysis (Fajardo, 1995) which provides a tool to clarify and identify concepts and causal relationships at the institutional level. The identification of the concepts and causal relations in the grand system of relationships constitutes a solid foundation for the direction of the ICDP, mission, planning and strategy clarification, and for the SEMES.

2) A monitoring effort at the farm household level is composed of cross-sectional and time series indicators to be statistically (STAT) analyzed that monitor short-term behavior of farm households in the on-going socioeconomic process.

Evaluation System

The actual and future situations of the Malagasy ICDPs result from an institutional dimension of change, itself based in the evolution of concepts built from evolving beliefs, values, and incentives in Madagascar's conservation and development paradigm.

The management of change relates the institutional dimension of change to the SEMES which focuses on the relationships among the institutional, rural household and protected area sets (Figure 1.2). One main "raison d'être" of the SEMES is to test the hypothesis established from planning about conservation and development and from introducing development activities. The desire is that the well-being of the rural households will increase, and the pressures on protected areas will decrease or cease.

From the standpoint of the grand system of relationships (Figure 4.3), actors who manage organizations within the institutions and farm households share loosely defined perceptions about ways to address needs and aspirations. Mission, strategies, causal relationships, and actions viewed from each actor's perspectives influence planning, monitoring and evaluation of ICDPs. As pointed out by Gilbert and Dodds (1992) and Blaikie and Jeanrenaud (1996), each actor views, understands and experiences "wildlife" and "biodiversity" from different social, cultural and economic backgrounds and values.

Differences prevail in perspectives (including values and socioeconomic observations), goals and objectives of the actors. By adapting the evaluation summary and relationships in Figure 6.1 to each organization's and actor's rationale, one obtains Figure 6.2 where foci of interests differ around a point of joint concern for Madagascar's

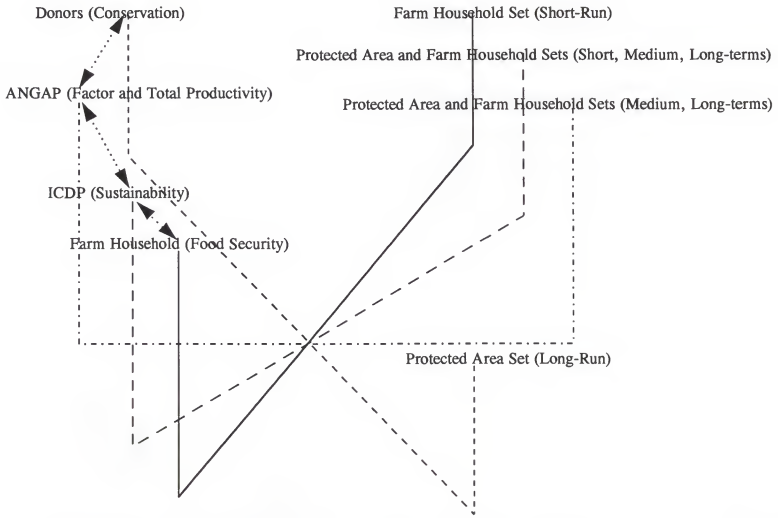

Figure 6.2. Differences in perspectives, goals and objectives of actors in ICDPs

present well-being and future. Donors provide money for a priority given to conservation, and view socioeconomic development as a means to achieve that goal. ANGAP, as a national coordinating body, sees improving factor and total productivity of peripheral zone farm households as a priority to achieve the goal of reducing human pressure. The ICDP manages for sustainability in dealing with field conservation and socioeconomic development. Farm households manage first for their food security (Barbour et al., 1992; Swanson, 1995, 1996). All actors are aware of the importance of resilience of ecosystems and farm households. Yet, such differing foci create divergent planning and expectation frameworks, different targeted sets (protected area set and/or farm household set) and inconsistent time (short-, medium- and/or long-term) perspectives and expectations for the managers of activities to achieve results. The SEMES, in confronting these differences, relies on the LPM at the household level and the ICP evaluation model at the institutional level as tools to provide convergence toward more meaningful and operational concepts and relationships that will assist management of ICDPs in Madagascar.

Monitoring System

Introducing development activities will bring new and/or "improved" technology and/or practices to Malagasy farm households in peripheral zones of protected areas. These introductions, it is believed, will improve well-being of farm households, and at the same time contribute to conservation of protected areas. The introduction of technology is a process formally sketched in a research-extension framework with the

technology innovation process (TIP) model (Figure 6.3; adapted from McDermott and Andrew, 1995).

The left hand side of the modified TIP shows the actors with their objectives, and the degree of closeness to field understanding (practical <---> theoretical). The world stock of knowledge,[2] which is the basis for the field level understanding, includes all forms of written, unwritten, experimental and reasoned knowledge. It extends in this conceptualization from theory to practice. In other words, at the level of donors, including some international consultancies, "book or shelf knowledge" predominates. Ignorance and arrogance at times can prevail in dealing with field situations. At the farm household level, "field experience" prevails. Disagreement and stubbornness might prevail in dealing with outsiders. As one moves from the donors to farm households, the share of field experience increases while that of "book knowledge" decreases. At each step of the TIP, similar donor to farm household "misunderstandings" might occur.

The remaining portion of the TIP depicts the process of moving from the world stock of knowledge through research and technology generation, testing, adaptation, integration and dissemination to ultimate diffusion and adoption. These tasks are accomplished in various organizational structures, including subject-matter research, area-specific research, technical liaison and support (sometimes referred to as extension specialist), and field extension. The actors involved in the ICDP system from donors

[2] "A sociology of scientific knowledge indicates that scientific "facts" are used to support various intellectual projects, upon which reputation, promotion and consultancy fees depend. Therefore discourses take place at many different levels and by a wide cast of protagonists." (Blaikie and Jeanrenaud, 1996, p. 1)

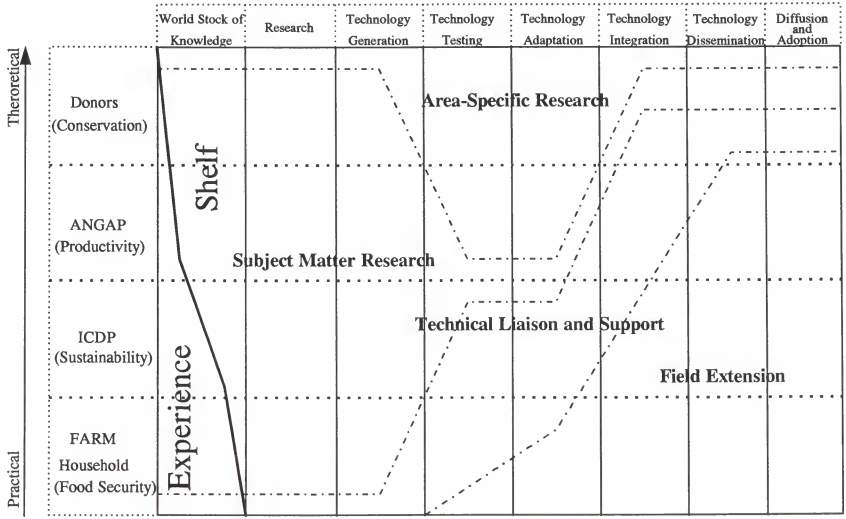

Figure 6.3. The technology innovation process (TIP) and ICDPs' actors

Source: Adapted from McDermott and Andrew. Agricultural Program Management. 1995. U.Fl.

through ANGAP, DEF, and ICDP management to the farm household, interact with the technology innovation process in different ways due to their goal orientations.

The introduction of development activities in Madagascar is designed to induce changes in resource allocation and use, and technological and technical processes of the farm households. "Introduced" new and/or "improved" technology and technical processes bring pressures and cause stresses to the households' systems that tend to induce disequilibrium in the local culture and socioeconomy (McDermott and Andrew, 1995). Such disequilibrium might work toward reinforcing the resilience of the protected area and/or farm households. It might also weaken either or both.

The LPM and statistical indicators (STAT) are monitoring tools to assist management of ICDPs in Madagascar and insure that adverse impacts of development activities are minimized, while direction is maintained toward expectations.

Socioeconomic Monitoring and Evaluation System (SEMES)

The SEMES (Figure 6.4) results from combining the planning-monitoring-evaluation model (Figure 6.1) with the operational model (Figure 1.3). As a result, ex-ante evaluation comprises the ICP evaluation model, and the linear programming model (LPM) at its interface with monitoring. Monitoring follows statistical indicators (STAT) in the "real world" for maintaining direction from ex-ante evaluation. Ex-post evaluation in the future will be based on those statistical indicators.

From the results of the ICP evaluation model with support from the LPM, questions are to be asked such as the nature and types of development activities, what

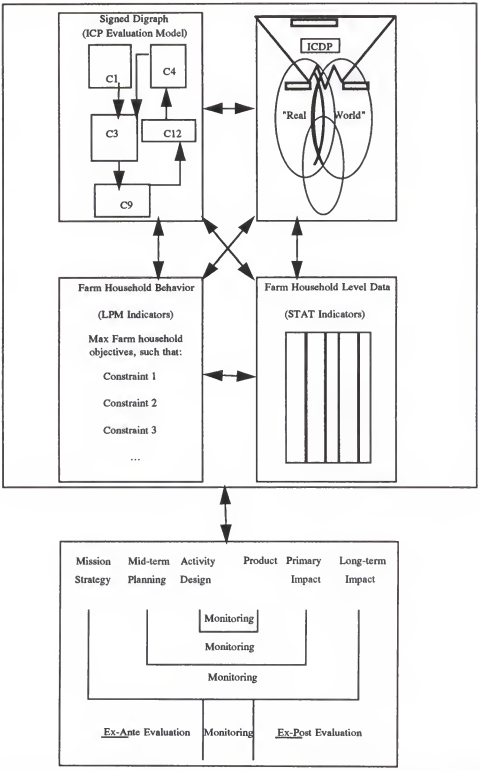

Figure 6.4. The socioeconomic evaluation and monitoring system (SEMES)

types of household units and members benefit, what direct and indirect impacts do these activities have on the farm households and protected area. Characterizing the farm households becomes crucial as well as looking at their objectives and constraints. A LPM at the farm level helps rationalize such understanding. Finally, comparison and evolution of socioeconomic indicators derived from both the institutional cognitive pattern and linear programming models need to be monitored across farm households, and from season to season and/or year to year, with statistical tests and tools.

As a general "summary" of the entire socioeconomic monitoring and evaluation process, content concerns including problems and causal relationships, research problems, hypotheses, objectives, beliefs-values, assumptions, observation criteria, metric indicators, information measurement and analysis are summarized in Table 6.1. From this overview, the complete task summarized in Figure 6.4 is initiated. The presentation of problems and causal relationships is one foundation for situation analysis, leading to the focus given by mission and strategy. Further specification is given to planning and project analysis through research (problems, hypotheses, objectives), and the context given by beliefs, values and assumptions. Project activity is then determined and bounded by observation criteria, metric indicators, and ultimately information measurement and analysis. The short- to long-term results are forthcoming as early products of the program, followed by primary impacts and long-terms impacts.

Table 6.1. Analytical Framework of Socioeconomic Monitoring and Evaluation of ICDP in Madagascar.

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Problems and Causal Relationships	Madagascar depends on international aid and assistance for conservation and socioeconomic development. Lack of scientific research findings in the monitoring-evaluation of the development process. Lack of sound scientific information on target groups and target areas. Lack of indicators and methods for assessing interactions among the different environmental, socioeconomic and developmental factors. Lack of reliable information in decision-making process.	Madagascar is one of the most environmentally at risk countries in the world. Concerns of conservation of disappearing unique and endemic natural resources and biodiversity.	Low performance technology and little technical improvement in agriculture-based economy lead to increased use of natural resources for food and income. * Macro scale: (population growth > production growth) + no or little technology and technical improvement + low income level ===> more resources used ===> environmental problems. * Micro scale: (Rural household food and income needs > production and consumption possibility) ===> poverty cycle + environmental problems.	Decline of socioeconomic standards of Madagascar to one of the poorest countries in the world. Population growth + inability to increase production accordingly + lack of access to food and non-food goods and services ===> loss of food security (chronic and transitory food insecurity).

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Research Problem	Insuring the management and operationality of the linkages between development activities and conservation.	Insuring the operationality and efficiency of a conservationist model.	Addressing simultaneously issues of socioeconomic development and environmental conservation. Providing sufficient domestic production and/or purchasing power while conserving and preserving the resource base, opening the potentials for sustainable maintenance and surplus in the available resources.	Focusing on a recursive system composed of resources, production and people.
Hypotheses	Identification, evaluation, and monitoring of development activities, which are technically, environmentally, socioeconomically, and institutionally feasible, by well-informed managers will improve well-being of peripheral zone farm households and decrease and/or cease pressures exerted by them in protected areas. A socioeconomic monitoring and evaluation system (SEMES) will have a positive impact on farm household welfare and reduce human pressures in the protected areas.	A socioeconomic monitoring and evaluation model will have a positive impact on human pressures on the protected areas.	Introducing development activities will improve well-being of rural households, decrease or cease pressures exerted by them in the protected areas.	A socioeconomic monitoring and evaluation model will have a positive impact on the welfare of rural households.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Objectives	- to contribute to the success, efficiency and sustainability of new approaches to viable environmental management. - to provide perennial management tools through a socioeconomic monitoring and evaluation model that can detect success or failure, efficiency and sustainability of development activities in reducing human pressures in protected areas. - to review and synthesize the literature on values, ethics, equity and sustainability issues involved in conservation and development paradigm. - to provide a conceptual framework of a socioeconomic monitoring and evaluation system.	- to understand production, income generation and food consumption mechanisms relative to resource allocation and use in protected areas. - to develop indicators addressing cross-sectional and time-series issues of the conservation. - to identify the food insecure households and the determinants of natural resource use and allocation by region and season. - to apply the model to Malagasy ICDP to investigate the issues of conservation. - to provide insights on policies regulating and affecting ICDPs.	- to understand production, income generation and food consumption mechanisms relative to resource allocation and use from introduced development activities. - to develop indicators addressing cross-sectional and time-series issues of the conservation and development paradigm. - to identify the food insecure households and the determinants of adoption/efficiency of introduced development activities. - to identify development activities that are crucial from both demand and supply perspectives. - to identify and propose some policy alternatives to food security, allowing the orientation of the government policies in rural fields such as agricultural and environmental research and extension. - to apply the model to the Malagasy ICDP to investigate the issues in the conservation and development paradigm - to provide insights on policies regulating and affecting ICDPs.	- to understand production, income generation and food consumption mechanisms relative to resource allocation and use in rural household farming system. - to develop indicators addressing cross-sectional and time-series issues of socioeconomic development. - to identify the food insecure households and the determinants of food security by region and season. - to identify food and non-food goods and services that are crucial from both demand and supply perspectives. - to identify and propose policy alternatives to food security, allowing the orientation of the government policies in rural fields such as agricultural and environmental research and extension. - to apply the model to the Malagasy ICDP to investigate the issues in the conservation and development paradigm - to provide insights on policies regulating and affecting ICDPs.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Beliefs-Values	Different and conflicting beliefs, values, attitudes and incentives of people and institutional organizations in the conservation and development paradigm. Dependance on international aid and assistance for the conservation and socioeconomic development, especially for ICDPs. Two main approaches: 1) the preservationist model (isolating protected areas), and 2) the conservationist model (linking conservation issues to socioeconomic development strategies.) For the conservationist model, socioeconomic development of local population increases the efficiency of the conservation system of biodiversity.	Biodiversity is a public good, a human heritage to be preserved and conserved across generations. The loss of subsystems, such as fauna or flora species, endangers the resilience of ecosystems. Sources of loss of resilience of ecosystems are natural phenomena and human behavior. Negative externalities follow from rural households' poverty, impacting the resilience of ecosystems and the conservation of Biodiversity.	Poverty endangers resilience of rural household system, impacting negatively resilience of ecosystems and conservation of Biodiversity. Conservation-development issues must be addressed simultaneously for reasons of resilience and sustainability of biodiversity and population welfare. Renewable and non-renewable resources as well as socioeconomic growth must be sustained simultaneously, ethically and equitably. Short-term use of renewable and nonrenewable resources by rural households impact negatively the resilience of ecosystems in protected areas. Socioeconomic development activities to rural households and communities need to address and resolve issues of losses of resilience of ecosystems and rural household systems simultaneously, and of sustainability, ethics, equity and social welfare.	Madagascar is rapidly losing food security. Population growth is high and the population live in poverty. Chronic and transitory food insecurity exist. Population needs and wants, such as basic and sufficient production, income and food/non-food consumption, are not met. Sources of loss of resilience (defined as a sustainable livelihood carrying capacity) of rural households systems are population growth, availability of and access to food and non-food goods and services. Non-satisfaction of the rural households' short-term needs and wants sustains poverty. Renewable and non-renewable resources are used and allocated unproductively and inefficiently.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Assumption	Conflicts in the design, implementation, and monitoring and evaluation of ICDP are due to divergences of views from beliefs, values, attitudes and incentives of people and institutional organizations. The value of Biodiversity depends on the willingness of rural households, and local, national and international communities to pay for its conservation and/or to forego its use through time. Institutional organizations focus on conservation and social welfare. Rural households maximize private profit and satisfaction of needs. The preservationist model alone is not adequate. The conservationist model addresses the link between the issues of the conservation and socioeconomic development paradigm.	The local population views natural resources in the protected areas as endless ("Nature Cornucopian"). Outside communities, such as scientific, national and international, view natural resources in the protected areas as depleted by the local population ("Nature Anarchic": growing use and decline of natural resources.) The continuous unproductive and inefficient human use and allocation of renewable and non-renewable natural resources from protected areas increase the chance of loss of resilience of ecosystems. The short-term use and allocation of renewable and non-renewable natural resources from protected areas by rural households indicate the potential impacts of human behavior on resilience of ecosystems in protected areas.	There is a direct link between the use of renewable and non-renewable natural resources in protected areas (conservation) by local population and their welfare (development). The direct link addresses the issues of resilience and sustainability of biodiversity and population welfare. Community development activities address the issues of population growth and welfare. Individual-group activities address the issues of use and allocation of renewable and non-renewable resources, and in so doing the losses of resilience of ecosystems and rural household systems simultaneously, sustainably, ethically, and equitably.. For the conservationist model, introducing socioeconomic development activities into the rural household system affects its welfare and biodiversity conservation.	Population growth, and lack of availability of and access to food and non-food goods and services increases the chance of loss of resilience of rural household system. Farming systems and strategies of rural household to satisfy its short-term needs and wants indicate its level of productive and efficient use and allocation of renewable/non-renewable resources and of poverty. Chronic and transitory food insecurity can be tackled through availability and access to food and non-food goods and services (production, income, food/non-food consumption, socio-cultural development activities). Rural households act as private firms and consumers looking for their best welfare interests. Rural Households exert pressures on protected areas to satisfy short-term, mid-term and long-term needs and wants.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Criteria Observations	Conflicts are based on understanding, concepts, and relationships in the conservation and development paradigm from beliefs, values and incentives of people and institutional organizations: population growth -population needs and wants - production, income and consumption - use of renewable and non-renewable resources - environmental degradation. Resilience and sustainability of Biodiversity and population welfare. Sustainability, ethics, and equity.	Pressures exerted by rural households on protected areas. Human use and allocation of renewable and non-renewable natural resources from protected areas. Production, income and food/non-food consumption gained from pressures. Resilience of ecosystems.	Alternatives (community and individual-group development activities) for the satisfaction of population needs and wants. Relationships among socioeconomic development activities, rural household welfare and pressures on protected areas.	Population growth and poverty. Farming system, strategies and welfare of rural household. Use and allocation of renewable/non-renewable resources. Availability and access to food and non-food goods and services (production, income, food/non-food consumption possibility, socio-cultural development activities). Resilience of rural household system.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Indicators Metric	Linear programming model (LPM) at the household level. Institutional cognitive pattern (ICP) evaluation model at the institutional level. Monitoring introduced development activities with statistical tools (STAT). Trends of use of natural resources by rural households and communities.	Ranking of renewable and non-renewable natural resources overused. Ranking of destructive activities exerted by rural household in protected areas. Ranking of causes of pressures in relation to overuse. Ranking of introduced development activities addressing directly prior rankings. Inputs, productivity and production of renewable and non-renewable natural resources overused. Profit, income, consumption and profitability from destructive activities exerted by rural household in protected areas. Bio-ecological ties of all of the above to resilience of ecosystems.	General level (by farm household types, region and time) of inputs, productivity, production, profit, income, expenditures, consumption, profitability, and subsistence and market integration, required and brought by introduced development activities.	Population growth by census. Farming system and strategy (by types of farm households, region and time): general level of inputs, productivity, production, profit, income, expenditures, consumption, profitability, and subsistence and market integration.

Table 6.1 (continued)

Topic	*M & E System*	*Conservation*	*Development Activities*	*Population Development*
Information Measurements Analyses	Data from survey. Documentary. In implementing the SEMES, periodical workshops involving actors, such as USAID, ANGAP, and/or ICDPs, will validate the results from LPM, ICP evaluation model, and STAT.	USAID, ANGAP, and/or ICDPs. Conservation and development departments of ICDPs. Rural household use of renewable and non-renewable resources = g (development activities, farming system, pressures)	USAID, ANGAP, and/or ICDPs. Conservation and development departments of ICDPs. Rural household adoption of introduced activities = h (development activities, farming system, pressures)	USAID, ANGAP, and/or ICDPs. Conservation and development departments of ICDPs. Rural Household Welfare = f (development activities, farming system, pressures)

CHAPTER 7
CONCLUSION AND RECOMMENDATIONS

Conclusion

A fundamental issue in the conservation and development paradigm in Madagascar is how to sustain socioeconomic development, while simultaneously conserving resources and the environment for production, consumption, and human population livelihoods in general, in the short-term, and across generations. The focus is on a grand system of relationships composed of institutions, resources, and people.

A socioeconomic monitoring and evaluation system (SEMES) is designed, and provides a methodology for sustainability analysis of the Masoala Integrated Conservation and Development Project (ICDP) in northeastern Madagascar. It considers the ICDP managers' concerns for maintaining resilience of the protected area, along with well-being of nearby farm households. A general hypothesis is: development activities introduced by ICDP will affect positively farm households' livelihoods, and change their destructive behavior towards the protected area, thus decreasing and/or ceasing the human pressure in that protected area.

An overall objective of the study is to provide managers and decision-makers with the SEMES as a package of flexible, cost effective, and results-oriented management tools to meet their concerns and verify the general and other specific hypotheses.

Approach

The design of this research is prompted by concerns of:

1. Efficiency and management of conservation and socioeconomic development activities at the ICDP level.

2. Present and future resource constraints of ICDP, and uncertainty at different levels of institutions.

3. Imprecision and confusion about the philosophy, definitions, and approaches and methodologies for socioeconomic development activities at different institutional levels.

4. A broad range of philosophy, definitions, and understandings concerning the conservation and development paradigm.

5. Perceptions that protected area, farm household, institutional, and developmental activities, are systemic in nature and by definition within the integrated conservation and development paradigm.

This research responds to these concerns by proposing the socioeconomic monitoring and evaluation system (SEMES), illustrated by the Masoala ICDP case study where the first data on socioeconomic monitoring and evaluation is available.

The research approach combines a conventional (data analysis) approach--a linear programming model (LPM) and statistical analyses (STAT)--at the household level, and a participatory (participating actors) approach--institutional cognitive pattern (ICP) evaluation model--at the institutional level.

The Socioeconomic Monitoring and Evaluation System (SEMES)

The systemic nature of the components (protected area, farm household, institutions, development activities, and their environments) in the integrated conservation and development paradigm, calls for a systemic response (SEMES) to "resolve" conflicting situations therein.

The SEMES is composed of three systemic parts. The present work involves the Masoala case study in two of those parts as a means for validating the potential for SEMES. The components parts are:

1. A Linear Programming Model (LPM), as an interface between the "real world," an institutional evaluation model, and statistical analysis. It identifies, describes and analyses farm household circumstances, and relationships with the protected area. It is shown in the Masoala case study (Chapter 3) that a prioritized pressure can be tied to a specific subsystem in the farm household livelihood system, allowing for partial and/or more complex analysis as needed. In the resource and environment constrained ICDP, such flexibility and manageability are needed. It is the basis for the institutional evaluation, and conservation and development monitoring;

2. An Institutional Cognitive Pattern (ICP) evaluation model where beliefs, values and incentives of institutions converge into shared and more precise concepts and relationships in the ICDP for meaningful and operational actions and policies. As illustrated by the Masoala case (Chapter 5), tavy (slash and burn) pressure, for example, can be analyzed in that framework; and

3. Statistical analysis (STAT) for monitoring indicators from LPM and ICP is oriented to future monitoring and analysis.

The present focus of the Masoala case study targets development activities and indicators. In so doing, LPM and ICP evaluation models prove to be helpful in evaluating the circumstances of Masoala farm households, and the institutional setting. Future changes, and/or constancies, of well-targeted indicators are expected to signal positive or negative effects on sustainability of this ICDP, allowing for rectification, improvement, modification and/or reorientation of development activities. Also, signals provide tools to decision-makers, especially the ICDP managers, for management and policy making purposes. Monitoring with STAT, which was not part of this case study, will focus on the signals as time series indicators become available.

The ICDP

Results of the linear programming model (LPM) in the Masoala ICDP case study show that farm households act rationally, and perform pressure activities (tavy culture in this case) in the protected area because of their possibilities and constraints. Prohibiting the pressure dramatically decreases farm households welfare. Tavy pressure can be tied to the cropping system, a subsystem in the farm household livelihood, and therefore to a specific development activity introduced by ICDP. Constraints and performance for the success of that activity can be monitored and evaluated, and therefore managed more efficiently.

The institutional cognitive pattern (ICP) evaluation model shows that if restriction is made to the access of protected area with no compensating alternative given in the "traditional" setting of farm households, then population growth, and food and non-food demand increase will encourage the increase of secondary forests and depletion of primary forests, natural resources, and biodiversity. The success of interventions might not be sustainable unless other issues, such as infrastructure and marketing systems, are considered and improved.

Recommendations: Prelude to Implementation

Widespread short- and long-term production, income and food/non-food consumption instability and food insecurity, lead to poverty for farm households. Sustainable poverty alleviation requires sufficient domestic production and/or purchasing power while conserving and preserving the resource base at the farm household level. Potentials for sustainable maintenance and surplus of input resources and product output must prevail. "Adequate" production, income earning ability and possibility, food/non-food consumption and food security would constitute prerequisites for sustainable socioeconomic development and growth, as well as for conservation and preservation of protected areas. This emphasis on "adequacy" must compensate farm households for not using the protected area.

Socioeconomic actors such as donors, international entities, national to local governments, Malagasy institutional organizations, ICDPs and farm households must be aware of the ethics, equity and sustainability issues concerning the development activities

to be introduced. For example, donors may not agree to change their priorities and short-term objectives from conservation, while the near starvation farm household in developing countries cannot agree today to be worse-off so that humanity is better-off in the future. Nor does it seem that households in a developed country will forego consumption excesses for the long-run goal.

The SEMES

The proposed SEMES can be of use soon, as it is composed of three related, and reinforcing subsystems, providing a basis for on-going assessment and management. At any initial time t_0, with or without the development activity, LPM and ICP evaluation identify constraints and alternatives to farm household systems. Indicators for STAT are identified. Monitoring indicators with STAT begins with LPM and ICP evaluation model, describing cross-sectionally the actual socioeconomic situation of the farm households. At a time t_1, in our case a season or a year, the development activity brings changes in the farm household livelihood system and in its behavior on farm and in protected area. Both cross-sectional and short-term information will result from the indicators. Hypotheses 1, 2, 3 and 4 can be tested at any time t_n, and from time t_n to t_{n+m}, n,m = 0,1,.... Findings about the indicators in time t_n and t_{n+m} will be the bases for hypothesis testing in time t_{n+m+1}, and so on.

The ICDP

In preparing for an effective and appropriate evaluation and monitoring system for the ICDPs, the following recommendations represent a format for consideration.

1. Identify and describe production, income and consumption patterns and relationships. Patterns and relationships are examined for farm households having different socioeconomic characteristics relative to allocation and use of resources in protected areas, development activities and farming systems.

2. Identify and describe cross-sectional and time-series socioeconomic indicators for monitoring and ex-post evaluations of: 1) resource use in protected areas by farm households; 2) farm household livelihood; and 3) introduced development activities.

3. Analyze the determining factors of production, income and consumption with respect to natural resource use, introduced development activities and farm household farming systems.

4. Describe and analyze the extent to which peripheral zone farm households are food insecure.

5. Identify the types of farm households that are food insecure in the peripheral zone. This part of the analysis assesses the scope for "targeting" income sources of the poor and the vulnerable groups.

6. Identify and analyze the concepts and relationships in an ICP evaluation model for the ICDPs.

7. Identify possible efficient interventions through agricultural development programs.

Also as consideration for further research, changes and trends will vary by region, household unit and gender. They will define: 1) the constraints and positive factors for farm household productivity, production, profit, income and consumption; 2) farm household standard of living; and 3) the impacts of the development activities on farm household behavior towards the use of natural resources in protected areas.

In application, the framework to be proposed will provide the basis for observing other propositions over time to extend the hypotheses and objectives of this research and the ICDP:

- Resource allocation decisions in farm household production subsystems will change as well as the activities, and operations in each activity.

- Total productivity and that of each activity will change, as will the role, task and share of household members in each activity.

- The increase in productivity with the development activity will compensate or exceed the income and consumption opportunities foregone in the protected area.

- With the introduced development activities, less time will be spent in the protected area, and more time will be devoted to labor or leisure, outside the protected area.

- Seasonal (normal and hungry seasons) and regional fluctuations in income and prices affect quantity of food demand.

- The importance of rice as a staple food and commercial crop in Madagascar makes it a primary commodity focus for study. However, rice must be viewed in a rice-based broader system. Seasons and regions influence the price (own-, and cross-) and income elasticities for rice and other staple foods.

- The income and substitution effects in rice consumption determine the patterns of food consumption, focusing on diet diversity and food supply, especially in the use of natural resources.

- Seasons and regions determine food demand and consumption patterns, and extend to natural resource use in protected areas. It is expected that the socioeconomic and biophysical characteristics of the regions herein play an important role.

- Supply elasticities by season and region differ because of 1) the levels of input used and levels of pressure on the use of limited low- and rainfed- lands (both critical in the seasonal outcome of rice production); 2) some regional socio-cultural and economic characteristics of the households such as the level of education, assets and income; and 3) heterogeneous intra- and interregional infrastructural facilities.

- Cross-sectional and time-series indicators of farm household allocation and use of resources in 1) natural resources, 2) introduced development activities and 3) farm household farming systems permit comparison of changes and trends stimulated by development activities.

Finally, the goal is to understand the evolving situation for sustainable integrated conservation and development in the Malagasy project areas and beyond. Such

understanding will assist project managers and policy makers, and ultimately the people of Madagascar.

The people of Madagascar, possibly as much or more than any other people in the world, are challenged very directly today with the need for sustainable conservation of their environment and biodiversity, and socioeconomic development.

APPENDIX A

LPM: RICE 1 AND TAVY, PURCHASE OF TAVY

LPM: Rice 1 and Tavy, Purchase of Tavy

	Row name	RI1	RI1S	RI1C	RI1P	RI2	RI2S	RI2C	RI2P	TAV	TAVS	TAVC	TAVP
		(ha)	(kg)	(kg)	(kg)	(ha)	(kg)	(kg)	(kg)	(ha)	(kg)	(kg)	(kg)
	Variables	0.974	272.790	516.000	0.000	0.000	0.000	0.000	258.000	1.807	699.493	258.000	0.000
	LdRI1 (ha)	1	0	0	0	0	0	0	0	0	0	0	0
	LdRI2 (ha)	0	0	0	0	1	0	0	0	0	0	0	0
	LdTV (ha)	0	0	0	0	0	0	0	0	0	0	0	0
	LdSBS (ha)	0	0	0	0	0	0	0	0	0	0	0	0
	LdCSH (ha)	0	0	0	0	0	0	0	0	0	0	0	0
January	LbJA (days)	0	0	0	0	17	0	0	0	8	0	0	0
February	LbFB (days)	19	0	0	0	3	0	0	0	4	0	0	0
March	LbMR (days)	18	0	0	0	3	0	0	0	4	0	0	0
April	LbAP (days)	21	0	0	0	3	0	0	0	4	0	0	0
May	LbMY (days)	20	0	0	0	16	0	0	0	4	0	0	0
June	LbJN (days)	8	0	0	0	15	0	0	0	12	0	0	0
July	LbJL (days)	8	0	0	0	0	0	0	0	11	0	0	0
August	LbAG (days)	8	0	0	0	0	0	0	0	0	0	0	0
September	LbSP (days)	21	0	0	0	0	0	0	0	0	0	0	0
October	LbOC (days)	21	0	0	0	0	0	0	0	0	0	0	0
November	LbNV (days)	0	0	0	0	15	0	0	0	11	0	0	0
December	LbDC (days)	0	0	0	0	14	0	0	0	11	0	0	0
	RI (kg)	-810	1	1	0	0	0	0	0	0	0	0	0
	RI1C/RI1P (kg)	0	0	-1	-1	0	0	0	0	0	0	0	0
	RI2 (kg)	0	0	0	0	-648	1	1	0	0	0	0	0
	RI2C/RI2P (kg)	0	0	0	0	0	0	-1	-1	0	0	0	0
	TAV (kg)	0	0	0	0	0	0	0	0	-530	1	1	0
	TAVC/TAVP (kg)	0	0	0	0	0	0	0	0	0	0	-1	-1
	CAS (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	CASC(kg)	0	0	0	0	0	0	0	0	0	0	0	0
	SGC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	SGCC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	BAN (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	BANC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	TAR (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	TARC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	COF (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	COFC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	CLO (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	VAN (kg)	0	0	0	0	0	0	0	0	0	0	0	0
	CSH1 (Frng)	15000	0	0	0	0	0	0	0	0	0	0	0
	CSH2 (Frng)	0	-1050	0	1250	15000	0	0	0	15000	0	0	0
	CSH3 (Frng)	0	0	0	0	0	1500	0	-1750	0	1300	0	-1500

LPM: Rice 1 and Tavy, Purchase of Tavy (continued)

CAS (ha)	CASS (kg)	CASC (kg)	SGC (ha)	SGCS (kg)	SGCC (kg)	BAN (ha)	BANS (kg)	BANC (kg)	TAR (ha)	TARS (kg)	TARC (kg)
0.087	0.000	520.000	0.103	0.000	175.000	0.270	746.176	65.000	0.040	0.000	260.000
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	6	0	0	7	0	0	7	0	0
10	0	0	10	0	0	7	0	0	7	0	0
10	0	0	10	0	0	7	0	0	7	0	0
10	0	0	15	0	0	7	0	0	13	0	0
10	0	0	15	0	0	7	0	0	12	0	0
22	0	0	1	0	0	2	0	0	12	0	0
21	0	0	1	0	0	2	0	0	0	0	0
21	0	0	1	0	0	2	0	0	0	0	0
0	0	0	1	0	0	2	0	0	0	0	0
0	0	0	1	0	0	2	0	0	10	0	0
12	0	0	1	0	0	2	0	0	10	0	0
21	0	0	1	0	0	2	0	0	8	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
-6000	1	1	0	0	0	0	0	0	0	0	0
0	0	-1	0	0	0	0	0	0	0	0	0
0	0	0	-1700	1	1	0	0	0	0	0	0
0	0	0	0	0	-1	0	0	0	0	0	0
0	0	0	0	0	0	-3000	1	1	0	0	0
0	0	0	0	0	0	0	0	-1	0	0	0
0	0	0	0	0	0	0	0	0	-6500	1	1
0	0	0	0	0	0	0	0	0	0	0	-1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	170	0	0	1000	0	0	1000	0	0	250	0

LPM: Rice 1 and Tavy, Purchase of Tavy (continued)

COF (ha)	COFS (kg)	COFC (kg)	CLO (ha)	CLOS (kg)	VAN (ha)	VANS (kg)	CSH1 (Fmg)	CSH2 (Fmg)		RHS	Res. Use	
0.284	241.147	12.000	0.000	0.000	0.238	105.158	392.781	1336792.125				
0	0	0	0	0	0	0	0	0	<=	1.00	0.97	
0	0	0	0	0	0	0	0	0	<=	1.00	0.00	
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	0.5	0.50	
1	0	0	1	0	1	0	0	0	<=	0.5	0.50	
1	0	0	1	0	1	0	0	0	<=	33	18.61	January
1	0	0	1	0	1	0	0	0	<=	33	30.30	February
1	0	0	1	0	1	0	0	0	<=	33	29.32	March
1	0	0	22	0	1	0	0	0	<=	33	33.00	April
1	0	0	22	0	1	0	0	0	<=	33	31.89	May
1	0	0	22	0	1	0	0	0	<=	33	33.00	June
10	0	0	21	0	1	0	0	0	<=	33	33.00	July
10	0	0	0	0	4	0	0	0	<=	33	13.84	August
10	0	0	1	0	14	0	0	0	<=	33	27.04	September
1	0	0	1	0	13	0	0	0	<=	33	24.83	October
0	0	0	1	0	4	0	0	0	<=	33	22.90	November
1	0	0	1	0	1	0	0	0	<=	33	23.18	December
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	-518	-518.00	
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	-268	-268.00	
0	0	0	0	0	0	0	0	0	<=	0	-0.00	
0	0	0	0	0	0	0	0	0	<=	-268	-268.00	
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	-520	-520.00	
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	-175	-175.00	
0	0	0	0	0	0	0	0	0	<=	0	0.00	
0	0	0	0	0	0	0	0	0	<=	-85	-85.00	
0	0	0	0	0	0	0	0	0	<=	0	-0.00	
0	0	0	0	0	0	0	0	0	<=	-280	-280.00	
-980	1	1	0	0	0	0	0	0	<=	0	0.00	
0	0	-1	0	0	0	0	0	0	<=	-12	-12.00	
0	0	0	-405	1	0	0	0	0	<=	0	0.00	
0	0	0	0	0	-445	1	0	0	<=	0	0.00	
0	0	0	0	0	0	0	1	0	<=	15000	15000.00	
0	-2500	0	0	0	0	-4500	-1	1	<=	0	0.00	
0	0	0	0	1000	0	0	0	1	>=	0	2639809.73	Cash End Year (Fmg)

LPM: Rice 1 and Tavy, Purchase of Tavy (continued)

Answer Report

Solution Cell	Starting	Final
CSH3 (Fmg)	0.000	2539809.732

Variable Cells	Starting	Final	Gradient	Increment	Decrement	
R11	0.000	0.974	0.000	505706.333	356722.222	R11
R11S	0.000	272.790	0.000	200.000	440.398	R11S
R11C	0.000	516.000	0.000	1050.000	200.000	R11C
R11P	0.000	0.000	0.000	200.000	Infinite	R11P
R12	0.000	0.000	0.000	922706.818	Infinite	R12
R12S	0.000	0.000	1500.000	250.000	Infinite	R12S
R12C	0.000	0.000	0.000	1423.930	250.000	R12C
R12P	0.000	258.000	-1750.000	250.000	1423.930	R12P
TAV	0.000	1.807	0.000	535083.333	96325.397	TAV
TAVS	0.000	699.493	1300.000	200.000	181.746	TAVS
TAVC	0.000	258.000	0.000	1300.000	200.000	TAVC
TAVP	0.000	0.000	-1500.000	200.000	Infinite	TAVP
CAS	0.000	0.087	0.000	3061433.333	Infinite	CAS
CASS	0.000	0.000	170.000	510.239	Infinite	CASS
CASC	0.000	520.000	0.000	680.239	Infinite	CASC
SGC	0.000	0.103	0.000	1402299.242	Infinite	SGC
SGCS	0.000	0.000	1000.000	824.882	Infinite	SGCS
SGCC	0.000	175.000	0.000	1824.882	Infinite	SGCC
BAN	0.000	0.270	0.000	Infinite	1402299.242	BAN
BANS	0.000	746.176	1000.000	Infinite	467.433	BANS
BANC	0.000	65.000	0.000	1000.000	Infinite	BANC
TAR	0.000	0.040	0.000	1495359.091	Infinite	TAR
TARS	0.000	0.000	250.000	230.055	Infinite	TARS
TARC	0.000	260.000	0.000	480.055	Infinite	TARC
COF	0.000	0.264	0.000	91484.925	397500.000	COF
COFS	0.000	241.147	0.000	95.297	414.062	COFS
COFC	0.000	12.000	0.000	2500.000	Infinite	COFC
CLO	0.000	0.000	0.000	3082531.061	Infinite	CLO
CLOS	0.000	0.000	1000.000	7611.188	1000.000	CLOS
VAN	0.000	0.236	0.000	397500.000	91484.925	VAN
VANS	0.000	105.156	0.000	893.258	205.584	VANS
CSH1	0.000	392.781	0.000	23.781	1.000	CSH1
CSH2	0.000	1335792.125	1.000	0.163	0.437	CSH2

LPM: Rice 1 and Tavy, Purchase of Tavy (continued)

	Cell	Value	Constraint	Binding?	Slack	Dual Value	Right Value	Increment	Decrement	
	LdRI1 (ha)	0.974	<=1	No	0.026	0.000	1.000	Infinite	0.026	LdRI1 (ha)
	LdRI2 (ha)	0.000	<=1	No	1.000	0.000	1.000	Infinite	1.000	LdRI2 (ha)
	LdTV (ha)	0.000	<=0	Yes	0.000	0.000	0.000	Infinite	0.000	LdTV (ha)
	LdS6S (ha)	0.500	<=0.5	Yes	0.000	2757074.242	0.500	0.975	0.076	LdS6S (ha)
	LdCSH (ha)	0.500	<=0.5	Yes	0.000	1629861.061	0.500	0.449	0.235	LdCSH (ha)
January	LbJA (days)	18.610	<=33	No	14.390	0.000	33.000	Infinite	14.390	LbJA (days)
February	LbF6 (days)	30.288	<=33	No	2.702	0.000	33.000	Infinite	2.702	LbF6 (days)
March	LbMR (days)	29.324	<=33	No	3.676	0.000	33.000	Infinite	3.676	LbMR (days)
April	LbAP (days)	33.000	<=33	Yes	0.000	19457.576	33.000	0.460	6.174	LbAP (days)
May	LbMY (days)	31.986	<=33	No	1.014	0.000	33.000	Infinite	1.014	LbMY (days)
June	LbJN (days)	33.000	<=33	Yes	0.000	9194.697	33.000	2.469	1.440	LbJN (days)
July	LbJL (days)	33.000	<=33	Yes	0.000	44166.667	33.000	2.127	2.281	LbJL (days)
August	LbAG (days)	13.636	<=33	No	19.164	0.000	33.000	Infinite	19.164	LbAG (days)
September	LbSP (days)	27.039	<=33	No	5.961	0.000	33.000	Infinite	5.961	LbSP (days)
October	LbOC (days)	24.829	<=33	No	8.171	0.000	33.000	Infinite	6.171	LbOC (days)
November	LbNV (days)	22.901	<=33	No	10.099	0.000	33.000	Infinite	10.099	LbNV (days)
December	LbDC (days)	23.156	<=33	No	9.844	0.000	33.000	Infinite	9.844	LbDC (days)
	RI1 (kg)	0.000	<=0	Yes	0.000	1050.000	0.000	Infinite	272.790	RI1 (kg)
	RI1C/RI1P (kg)	-516.000	<=-516	Yes	0.000	1050.000	-516.000	516.000	272.790	RI1C/RI1P (kg)
	RI2 (kg)	0.000	<=0	Yes	0.000	1750.000	0.000	256.000	0.000	RI2 (kg)
	RI2C/RI2P (kg)	-258.000	<=-258	Yes	0.000	1750.000	-258.000	258.000	1451.320	RI2C/RI2P (kg)
	TAV (kg)	-0.000	<=0	Yes	0.000	1300.000	0.000	Infinite	886.493	TAV (kg)
	TAVC/TAVP (kg)	-258.000	<=-258	Yes	0.000	1300.000	-258.000	258.000	689.493	TAVC/TAVP (kg)
	CAS (kg)	0.000	<=0	Yes	0.000	880.239	0.000	520.000	786.561	CAS (kg)
	CASC(kg)	-520.000	<=-520	Yes	0.000	880.236	-520.000	520.000	786.561	CASC(kg)
	SGC (kg)	0.000	<=0	Yes	0.000	1624.862	0.000	97.933	422.633	SGC (kg)
	SGCC (kg)	-175.000	<=-175	Yes	0.000	1624.862	-175.000	97.933	422.633	SGCC (kg)
	BAN (kg)	0.000	<=0	Yes	0.000	1000.000	0.000	Infinite	746.178	BAN (kg)
	BANC (kg)	-85.000	<=-85	Yes	0.000	1000.000	-85.000	85.000	746.178	BANC (kg)
	TAR (kg)	-0.000	<=0	Yes	0.000	480.055	0.000	260.000	1227.297	TAR (kg)
	TARC (kg)	-280.000	<=-280	Yes	0.000	480.055	-280.000	280.000	1227.297	TARC (kg)
	COF (kg)	0.000	<=0	Yes	0.000	2500.000	0.000	Infinite	241.147	COF (kg)
	COFC (kg)	-12.000	<=-12	Yes	0.000	2500.000	-12.000	12.000	241.147	COFC (kg)
	CLO (kg)	0.000	<=0	Yes	0.000	1000.000	0.000	Infinite	0.000	CLO (kg)
	VAN (kg)	0.000	<=0	Yes	0.000	4500.000	0.000	Infinite	106.156	VAN (kg)
	CSH1 (Fmg)	15000.000	<=15000	Yes	0.000	1.000	15000.000	Infinite	392.761	CSH1 (Fmg)
	CSH2 (Fmg)	0.000	<=0	Yes	0.000	1.000	0.000	Infinite	1336792.125	CSH2 (Fmg)
	CSH3 (Fmg)	2639809.732	>=0	No	2639809.732	0.000	0.000	2639809.732	Infinite	CSH3 (Fmg)

LPM: Rice 1 and Tavy, Purchase of Tavy (continued)

RI1	0.974 >= 0	No	0.974	0.000	0.000	0.974	Infinite	RI1
RI1S	272.790 >= 0	No	272.790	0.000	0.000	272.790	Infinite	RI1S
RI1C	516.000 >= 0	No	516.000	0.000	0.000	516.000	Infinite	RI1C
RI1P	0.000 >= 0	Yes	0.000	-200.000	0.000	516.000	272.790	RI1P
RI2	0.000 >= 0	Yes	0.000	822706.618	0.000	0.000	Infinite	RI2
RI2S	0.000 >= 0	Yes	0.000	-250.000	0.000	10169.239	0.000	RI2S
RI2C	0.000 >= 0	Yes	0.000	0.000	0.000	0.000	Infinite	RI2C
RI2P	258.000 >= 0	No	258.000	0.000	0.000	258.000	Infinite	RI2P
TAV	1.807 >= 0	No	1.807	0.000	0.000	1.807	Infinite	TAV
TAVS	699.493 >= 0	No	699.493	0.000	0.000	699.493	Infinite	TAVS
TAVC	258.000 >= 0	No	258.000	0.000	0.000	258.000	Infinite	TAVC
TAVP	0.000 >= 0	Yes	0.000	-200.000	0.000	256.000	699.493	TAVP
CAS	0.087 >= 0	No	0.087	0.000	0.000	0.087	Infinite	CAS
CASS	0.000 >= 0	Yes	0.000	-510.238	0.000	765.561	520.000	CASS
CASC	520.000 >= 0	No	520.000	0.000	0.000	520.000	Infinite	CASC
SGC	0.103 >= 0	No	0.103	0.000	0.000	0.103	Infinite	SGC
SGCS	0.000 >= 0	Yes	0.000	-824.682	0.000	422.633	67.833	SGCS
SGCC	175.000 >= 0	No	175.000	0.000	0.000	175.000	Infinite	SGCC
6AN	0.270 >= 0	No	0.270	0.000	0.000	0.270	Infinite	6AN
6ANS	748.176 >= 0	No	748.176	0.000	0.000	748.176	Infinite	6ANS
6ANC	65.000 >= 0	No	65.000	0.000	0.000	65.000	Infinite	6ANC
TAR	0.040 >= 0	No	0.040	0.000	0.000	0.040	Infinite	TAR
TARS	0.000 >= 0	Yes	0.000	-230.055	0.000	1227.297	260.000	TARS
TARC	260.000 >= 0	No	260.000	0.000	0.000	260.000	Infinite	TARC
COF	0.284 >= 0	No	0.284	0.000	0.000	0.284	Infinite	COF
COFS	241.147 >= 0	No	241.147	0.000	0.000	241.147	Infinite	COFS
COFC	12.000 >= 0	No	12.000	0.000	0.000	12.000	Infinite	COFC
CL0	0.000 >= 0	Yes	0.000	-3062631.061	0.000	0.000	0.034	CL0
CLOS	0.000 >= 0	Yes	0.000	0.000	0.000	0.000	Infinite	CLOS
VAN	0.238 >= 0	No	0.236	0.000	0.000	0.236	Infinite	VAN
VANS	105.156 >= 0	No	105.156	0.000	0.000	105.156	Infinite	VANS
CSH1	392.761 >= 0	No	392.761	0.000	0.000	392.761	Infinite	CSH1
CSH2	1335792.125 >= 0	No	1335792.125	0.000	0.000	1335792.125	Infinite	CSH2

APPENDIX B

LPM: RICE 1 AND NO TAVY, NO PURCHASE OF TAVY

LPM: Rice 1 and no Tavy, no Purchase of Tavy

Row name	RI1 (ha)	RI1S (kg)	RI1C (kg)	RI1P (kg)	RI2 (ha)	RI2S (kg)	RI2C (kg)	RI2P (kg)	TAV (ha)	TAVS (kg)	TAVC (kg)	TAVP (kg)
Variables	1.000	0.000	810.000	222.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LdRI1 (ha)	1	0	0	0	0	0	0	0	0	0	0	0
LdRI2 (ha)	0	0	0	0	1	0	0	0	0	0	0	0
LdTV (ha)	0	0	0	0	0	0	0	0	0	0	0	0
LdSBS (ha)	0	0	0	0	0	0	0	0	0	0	0	0
LdCSH (ha)	0	0	0	0	0	0	0	0	0	0	0	0
January	LbJA (days)	0	0	0	0	17	0	0	0	8	0	0	0
February	LbFB (days)	19	0	0	0	3	0	0	0	4	0	0	0
March	LbMR (days)	18	0	0	0	3	0	0	0	4	0	0	0
April	LbAP (days)	21	0	0	0	3	0	0	0	4	0	0	0
May	LbMY (days)	20	0	0	0	16	0	0	0	4	0	0	0
June	LbJN (days)	8	0	0	0	15	0	0	0	12	0	0	0
July	LbJL (days)	8	0	0	0	0	0	0	0	11	0	0	0
August	LbAG (days)	8	0	0	0	0	0	0	0	0	0	0	0
September	LbSP (days)	21	0	0	0	0	0	0	0	0	0	0	0
October	LbOC (days)	21	0	0	0	0	0	0	0	0	0	0	0
November	LbNV (days)	0	0	0	0	15	0	0	0	11	0	0	0
December	LbDC (days)	0	0	0	0	14	0	0	0	11	0	0	0
RI1 (kg)	-810	1	1	0	0	0	0	0	0	0	0	0
RI1C/RI1P (kg)	0	0	-1	-1	0	0	0	0	0	0	0	0
RI2 (kg)	0	0	0	0	-648	1	1	0	0	0	0	0
RI2C/RI2P (kg)	0	0	0	0	0	0	-1	-1	0	0	0	0
TAV (kg)	0	0	0	0	0	0	0	0	-530	1	1	0
TAVC/TAVP (kg)	0	0	0	0	0	0	0	0	0	0	-1	-1
CAS (kg)	0	0	0	0	0	0	0	0	0	0	0	0
CASC(kg)	0	0	0	0	0	0	0	0	0	0	0	0
SGC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
SGCC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
BAN (kg)	0	0	0	0	0	0	0	0	0	0	0	0
BANC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
TAR (kg)	0	0	0	0	0	0	0	0	0	0	0	0
TARC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
COF (kg)	0	0	0	0	0	0	0	0	0	0	0	0
COFC (kg)	0	0	0	0	0	0	0	0	0	0	0	0
CLO (kg)	0	0	0	0	0	0	0	0	0	0	0	0
VAN (kg)	0	0	0	0	0	0	0	0	0	0	0	0
CSH1 (Fmg)	15000	0	0	0	0	0	0	0	0	0	0	0
CSH2 (Fmg)	0	-1050	0	1250	15000	0	0	0	15000	0	0	0
CSH3 (Fmg)	0	0	0	0	0	1500	0	-1750	0	1300	0	-1500

LPM: Rice 1 and no Tavy, no Purchase of Tavy

CAS (ha)	CASS (kg)	CASC (kg)	SGC (ha)	SGCS (kg)	SGCC (kg)	BAN (ha)	BANS (kg)	BANC (kg)	TAR (ha)	TARS (kg)	TARC (kg)
0.087	0.000	520.000	0.103	0.000	175.000	0.270	746.176	65.000	0.040	0.000	260.000
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	6	0	0	7	0	0	7	0	0
10	0	0	10	0	0	7	0	0	7	0	0
10	0	0	10	0	0	7	0	0	7	0	0
10	0	0	15	0	0	7	0	0	13	0	0
10	0	0	15	0	0	7	0	0	12	0	0
22	0	0	1	0	0	2	0	0	12	0	0
21	0	0	1	0	0	2	0	0	0	0	0
21	0	0	1	0	0	2	0	0	0	0	0
0	0	0	1	0	0	2	0	0	0	0	0
0	0	0	1	0	0	2	0	0	10	0	0
12	0	0	1	0	0	2	0	0	10	0	0
21	0	0	1	0	0	2	0	0	8	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
-6000	1	1	0	0	0	0	0	0	0	0	0
0	0	-1	0	0	0	0	0	0	0	0	0
0	0	0	-1700	1	1	0	0	0	0	0	0
0	0	0	0	0	-1	0	0	0	0	0	0
0	0	0	0	0	0	-3000	1	1	0	0	0
0	0	0	0	0	0	0	0	-1	0	0	0
0	0	0	0	0	0	0	0	0	-6500	1	1
0	0	0	0	0	0	0	0	0	0	0	-1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	170	0	0	1000	0	0	1000	0	0	250	0

LPM: Rice 1 and no Tavy, no Purchase of Tavy

COF (ha)	COFS (kg)	COFC (kg)	CLO (ha)	CLOS (kg)	VAN (ha)	VANS (kg)	CSH1 (Fmg)	CSH2 (Fmg)		RHS	Res. Use	
0.500	466.000	12.000	0.000	0.000	0.000	0.000	0.000	892500.000				
0	0	0	0	0	0	0	0	0	< =	1.00	1.00	
0	0	0	0	0	0	0	0	0	< =	1.00	0.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	0.5	0.50	
1	0	0	1	0	1	0	0	0	< =	0.5	0.50	
1	0	0	1	0	1	0	0	0	< =	33	4.16	January
1	0	0	1	0	1	0	0	0	< =	33	23.67	February
1	0	0	1	0	1	0	0	0	< =	33	22.67	March
1	0	0	22	0	1	0	0	0	< =	33	26.32	April
1	0	0	22	0	1	0	0	0	< =	33	26.26	May
1	0	0	22	0	1	0	0	0	< =	33	11.53	June
10	0	0	21	0	1	0	0	0	< =	33	15.46	July
10	0	0	0	0	4	0	0	0	< =	33	15.46	August
10	0	0	1	0	14	0	0	0	< =	33	26.84	September
1	0	0	1	0	13	0	0	0	< =	33	22.54	October
0	0	0	1	0	4	0	0	0	< =	33	2.08	November
1	0	0	1	0	1	0	0	0	< =	33	3.26	December
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	-1032	-1032.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	-520	-520.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	-175	-175.00	
0	0	0	0	0	0	0	0	0	< =	0	0.00	
0	0	0	0	0	0	0	0	0	< =	-85	-85.00	
0	0	0	0	0	0	0	0	0	< =	0	-0.00	
0	0	0	0	0	0	0	0	0	< =	-260	-260.00	
-980	1	1	0	0	0	0	0	0	< =	0	-0.00	
0	0	-1	0	0	0	0	0	0	< =	-12	-12.00	
0	0	0	-405	1	0	0	0	0	< =	0	0.00	
0	0	0	0	0	-445	1	0	0	< =	0	0.00	
0	0	0	0	0	0	0	1	0	< =	16000	16000.00	
0	-2500	0	0	0	0	-4500	-1	1	< =	0	0.00	
0	0	0	0	1000	0	0	0	1	> =	0	1836876.47	Cash End Year (Fmg)

Answer Report

Solution Cell	Starting	Final
CSH3 (Fmg)	0.000	1638676.471

Variable Cells	Starting	Final	Gradient	Increment	Decrement
RI1	0.000	1.000	0.000	Infinite	997500.000
RI1S	0.000	0.000	0.000	200.000	Infinite
RI1C	0.000	810.000	0.000	Infinite	200.000
RI1P	0.000	222.000	0.000	200.000	Infinite
RI2	0.000	0.000	0.000	957000.000	Infinite
RI2S	0.000	0.000	1500.000	1476.852	1500.000
RI2C	0.000	0.000	0.000	1500.000	Infinite
RI2P	0.000	0.000	-1750.000	1750.000	Infinite
TAV	0.000	0.000	0.000	15000.000	Infinite
TAVS	0.000	0.000	1300.000	1271.698	Infinite
TAVC	0.000	0.000	0.000	28.302	Infinite
TAVP	0.000	0.000	-1500.000	1500.000	Infinite
CAS	0.000	0.087	0.000	1980000.000	Infinite
CASS	0.000	0.000	170.000	330.000	Infinite
CASC	0.000	520.000	0.000	500.000	Infinite
SGC	0.000	0.103	0.000	1300000.000	Infinite
SGCS	0.000	0.000	1000.000	764.706	Infinite
SGCC	0.000	175.000	0.000	1764.706	Infinite
BAN	0.000	0.270	0.000	Infinite	1300000.000
BANS	0.000	746.176	1000.000	Infinite	433.333
BANC	0.000	65.000	0.000	1000.000	Infinite
TAR	0.000	0.040	0.000	1375000.000	Infinite
TARS	0.000	0.000	250.000	211.538	Infinite
TARC	0.000	260.000	0.000	461.538	Infinite
COF	0.000	0.500	0.000	Infinite	397500.000
COFS	0.000	468.000	0.000	Infinite	414.062
COFC	0.000	12.000	0.000	2500.000	Infinite
CLO	0.000	0.000	0.000	1995000.000	Infinite
CLOS	0.000	0.000	1000.000	4925.926	1000.000
VAN	0.000	0.000	0.000	397500.000	Infinite
VANS	0.000	0.000	0.000	893.258	Infinite
CSH1	0.000	0.000	0.000	66.500	Infinite
CSH2	0.000	892500.000	1.000	Infinite	0.831

LPM: Rice 1 and no Tavy, no Purchase of Tavy

	Cell	Value	Constraint	Binding?	Slack	Dual Value	Right Value	Increment	Decrement	
	LdRI1 (ha)	1.000	<=1	Yes	0.000	0.000	1.000	Infinite	0.000	LdRI1 (ha)
	LdRI2 (ha)	0.000	<=1	No	1.000	0.000	1.000	Infinite	1.000	LdRI2 (ha)
	LdTV (ha)	0.000	<=0	Yes	0.000	0.000	0.000	Infinite	0.000	LdTV (ha)
	LdSBS (ha)	0.500	<=0.5	Yes	0.000	3000000.000	0.500	0.964	0.249	LdSBS (ha)
	LdCSH (ha)	0.500	<=0.5	Yes	0.000	2400000.000	0.500	0.836	0.372	LdCSH (ha)
January	LbJA (days)	4.157	<=33	No	28.843	0.000	33.000	Infinite	28.843	LbJA (days)
February	LbFB (days)	23.569	<=33	No	9.431	0.000	33.000	Infinite	9.431	LbFB (days)
March	LbMR (days)	22.569	<=33	No	10.431	0.000	33.000	Infinite	10.431	LbMR (days)
April	LbAP (days)	26.324	<=33	No	6.676	0.000	33.000	Infinite	6.676	LbAP (days)
May	LbMY (days)	25.264	<=33	No	7.716	0.000	33.000	Infinite	7.716	LbMY (days)
June	LbJN (days)	11.530	<=33	No	21.470	0.000	33.000	Infinite	21.470	LbJN (days)
July	LbJL (days)	15.464	<=33	No	17.536	0.000	33.000	Infinite	17.536	LbJL (days)
August	LbAG (days)	15.464	<=33	No	17.536	0.000	33.000	Infinite	17.536	LbAG (days)
September	LbSP (days)	26.644	<=33	No	6.356	0.000	33.000	Infinite	6.356	LbSP (days)
October	LbOC (days)	22.544	<=33	No	10.456	0.000	33.000	Infinite	10.456	LbOC (days)
November	LbNV (days)	2.084	<=33	No	30.916	0.000	33.000	Infinite	30.916	LbNV (days)
December	LbDC (days)	3.284	<=33	No	29.716	0.000	33.000	Infinite	29.716	LbDC (days)
	RI1 (kg)	0.000	<=0	Yes	0.000	1260.000	0.000	222.000	714.000	RI1 (kg)
	RI1C/RI1P (kg)	-1032.000	<=-1032	Yes	0.000	1260.000	-1032.000	222.000	714.000	RI1C/RI1P (kg)
	RI2 (kg)	0.000	<=0	Yes	0.000	1500.000	0.000	Infinite	0.000	RI2 (kg)
	RI2C/RI2P (kg)	0.000	<=0	Yes	0.000	0.000	0.000	Infinite	0.000	RI2C/RI2P (kg)
	TAV (kg)	0.000	<=0	Yes	0.000	26.302	0.000	0.000	0.000	TAV (kg)
	TAVC/TAVP (kg)	0.000	<=0	Yes	0.000	0.000	0.000	Infinite	0.000	TAVC/TAVP (kg)
	CAS (kg)	0.000	<=0	Yes	0.000	500.000	0.000	520.000	1492.353	CAS (kg)
	CASC(kg)	-520.000	<=-520	Yes	0.000	500.000	-520.000	520.000	1492.353	CASC(kg)
	SGC (kg)	0.000	<=0	Yes	0.000	1764.706	0.000	175.000	422.633	SGC (kg)
	SGCC (kg)	-175.000	<=-175	Yes	0.000	1764.706	-175.000	175.000	422.633	SGCC (kg)
	BAN (kg)	0.000	<=0	Yes	0.000	1000.000	0.000	Infinite	746.176	BAN (kg)
	BANC (kg)	-65.000	<=-65	Yes	0.000	1000.000	-65.000	65.000	746.176	BANC (kg)
	TAR (kg)	-0.000	<=0	Yes	0.000	461.536	0.000	260.000	1616.716	TAR (kg)
	TARC (kg)	-260.000	<=-260	Yes	0.000	461.536	-260.000	260.000	1616.716	TARC (kg)
	COF (kg)	-0.000	<=0	Yes	0.000	2600.000	0.000	Infinite	357.000	COF (kg)
	COFC (kg)	-12.000	<=-12	Yes	0.000	2600.000	-12.000	12.000	357.000	COFC (kg)
	CLO (kg)	0.000	<=0	Yes	0.000	1000.000	0.000	Infinite	0.000	CLO (kg)
	VAN (kg)	0.000	<=0	Yes	0.000	5393.256	0.000	0.000	186.464	VAN (kg)
	CSH1 (Frng)	16000.000	<=16000	Yes	0.000	87.500	16000.000	0.000	13222.222	CSH1 (Frng)
	CSH2 (Frng)	0.000	<=0	Yes	0.000	1.000	0.000	Infinite	692500.000	CSH2 (Frng)
	CSH3 (Frng)	0.000	=0	Yes	0.000	0.000	0.000	0.000	Infinite	CSH3 (Frng)

LPM: Rice 1 and no Tavy, no Purchase of Tavy

RI1	0.000	=0	Yes	0.000	1271.698	0.000	0.000	Infinite	RI1
RI1S	0.000	=0	Yes	0.000	-28.302	0.000	0.000	Infinite	RI1S
RI1C	0.000	=0	Yes	0.000	-1500.000	0.000	0.000	Infinite	RI1C
RI1P	0.000	=0	Yes	0.000	957000.000	0.000	0.000	Infinite	RI1P
RI2	1638676.471	> =0	No	1638676.471	0.000	0.000	1638676.471	Infinite	RI2
RI2S	1.000	> =0	No	1.000	0.000	0.000	1.000	Infinite	RI2S
RI2C	0.000	> =0	Yes	0.000	-200.000	0.000	810.000	222.000	RI2C
RI2P	810.000	> =0	No	810.000	0.000	0.000	810.000	Infinite	RI2P
TAV	222.000	> =0	No	222.000	0.000	0.000	222.000	Infinite	TAV
TAVS	0.000	> =0	Yes	0.000	957000.000	0.000	0.000	Infinite	TAVS
TAVC	0.000	> =0	Yes	0.000	0.000	0.000	0.000	Infinite	TAVC
TAVP	0.000	> =0	Yes	0.000	-1500.000	0.000	0.000	0.000	TAVP
CAS	0.087	> =0	No	0.087	0.000	0.000	0.087	Infinite	CAS
CASS	0.000	> =0	Yes	0.000	-330.000	0.000	1492.353	520.000	CASS
CASC	520.000	> =0	No	520.000	0.000	0.000	520.000	Infinite	CASC
SGC	0.103	> =0	No	0.103	0.000	0.000	0.103	Infinite	SGC
SGCS	0.000	> =0	Yes	0.000	-764.706	0.000	422.833	175.000	SGCS
SGCC	175.000	> =0	No	175.000	0.000	0.000	175.000	Infinite	SGCC
BAN	0.270	> =0	No	0.270	0.000	0.000	0.270	Infinite	BAN
BANS	746.176	> =0	No	746.176	0.000	0.000	746.176	Infinite	BANS
BANC	65.000	> =0	No	65.000	0.000	0.000	65.000	Infinite	BANC
TAR	0.040	> =0	No	0.040	0.000	0.000	0.040	Infinite	TAR
TARS	0.000	> =0	Yes	0.000	-211.538	0.000	1616.716	260.000	TARS
TARC	260.000	> =0	No	260.000	0.000	0.000	260.000	Infinite	TARC
COF	0.500	> =0	No	0.500	0.000	0.000	0.500	Infinite	COF
COFS	468.000	> =0	No	468.000	0.000	0.000	468.000	Infinite	COFS
COFC	12.000	> =0	No	12.000	0.000	0.000	12.000	Infinite	COFC
CLO	0.000	> =0	Yes	0.000	-1995000.000	0.000	0.318	0.000	CLO
CLOS	0.000	> =0	Yes	0.000	0.000	0.000	0.000	Infinite	CLOS
VAN	0.000	> =0	Yes	0.000	0.000	0.000	0.000	Infinite	VAN
VANS	0.000	> =0	Yes	0.000	-893.258	0.000	0.000	867.071	VANS
CSH1	0.000	> =0	Yes	0.000	-66.500	0.000	13421.053	0.000	CSH1
CSH2	892500.000	> =0	No	892500.000	0.000	0.000	892500.000	Infinite	CSH2

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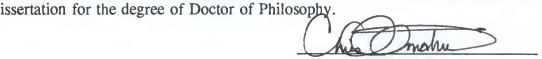
BIOGRAPHICAL SKETCH

Henri Lucien Abel-Ratovo was born on November 14, 1953, in Antsirabe, Madagascar. After graduating from the Civil Engineering Technical High School ("Lycée Technique du Génie Civil"), Antananarivo, Madagascar, with training in building and public works, he received his bachelor's degree ("maîtrise") in rural economics from "Institut Supérieur des Techniques d'Outre-Mer" (ISTOM), Le Havre, France. He then completed his Master degree ("Diplome d'Etudes Superieures Specialisées") in agricultural development from "Institut d'Etudes de Développement Economique et Social" (IEDES), University of Paris I, Pantheon-Sorbonne, France. This specialization towards the rural world led him to work as a researcher for the National Center of Applied Research to Rural Development ("FOFIFA") in Madagascar for about ten years. During that time, his professional journey around Madagascar and the world led him to pursue and complete the M.Sc. and Ph.D. programs in food and resource economics at the University of Florida, Gainesville, Fl, USA. He is a member of Phi Kappa Phi.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



Chris O. Andrew, Chair
Professor of Food and Resource Economics

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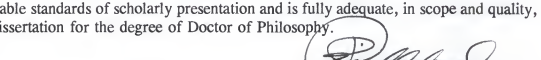

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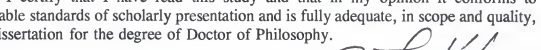

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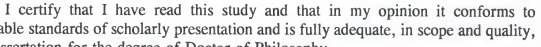

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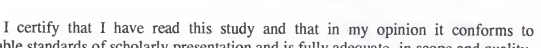

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This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1997

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